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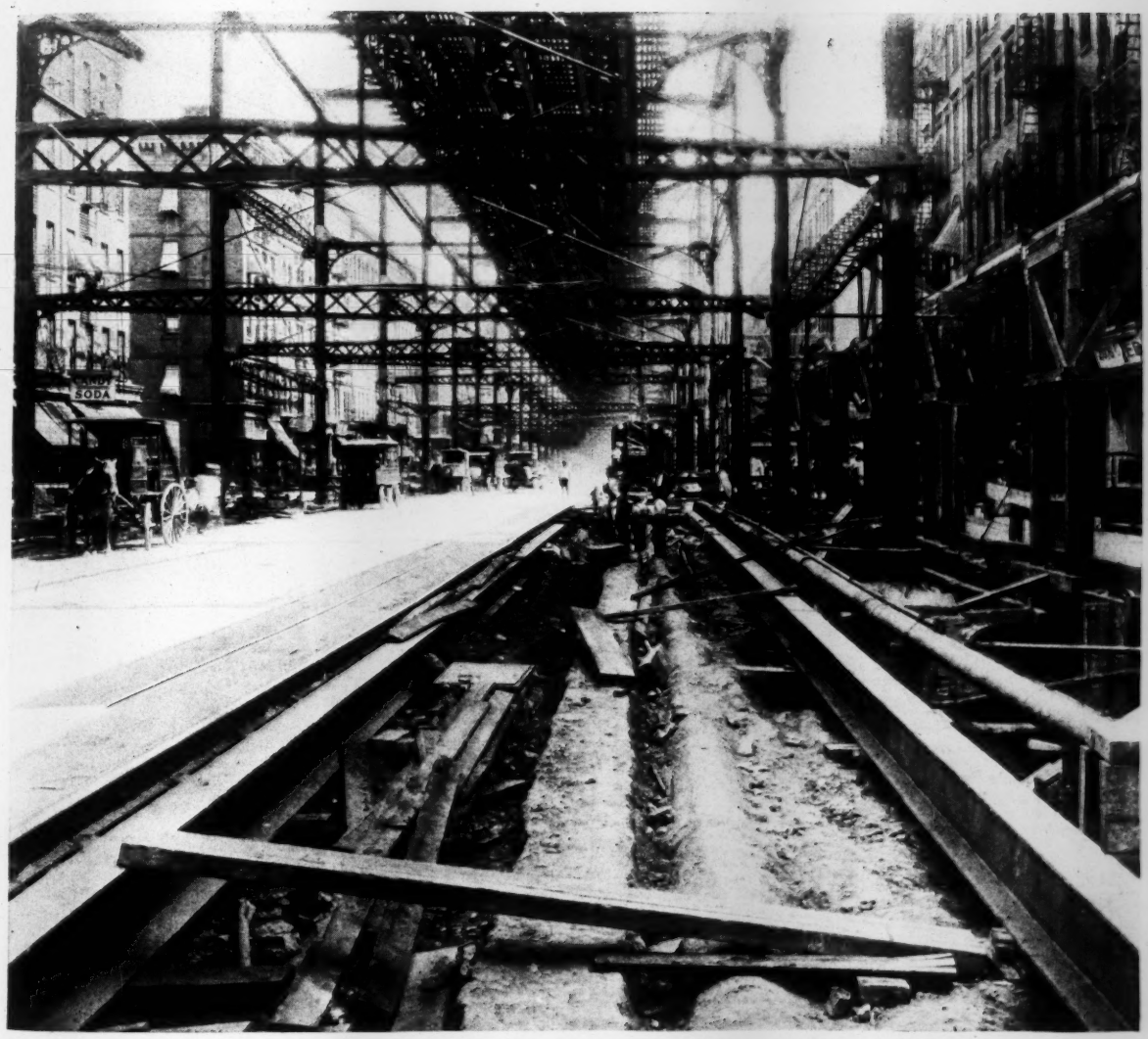

Starting subway construction on 8th Ave. near 116th St. where work is complicated by the necessity of underpinning the columns of the high elevated railway and the tracks of the surface line

Beginning

a series of articles on

New York's New Subway System

In this issue: **The Planning of New York's Third Subway System**

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ENGINEERING NEWS-RECORD

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JAMES H. McGRAW, *President*
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FRANK C. WIGHT
Editor

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Water-Works Papers

OUTSTANDING among the many papers read before the American Water Works Association at Buffalo last week was one by Prof. A. N. Talbot in which he reported at length the results of a unique series of tests on the strength of cast-iron pipe. It is hoped that this will be only the beginning of comparative tests of pipe cast by the old and new methods. Cast-iron pipe makes up so large a part of the capital investment in a water-works system that it deserves far more disinterested scientific study than it has received. The convention program included three other papers dealing with cast-iron pipe as a material and one on two mains in wide streets, besides several dealing with other parts of the distribution system. Summaries of these papers scattered through the program, are brought together elsewhere in this issue together with groups of papers on other of the principal elements in water-works systems.

Plant Plan Study

ECONOMIC studies of construction plant planning are infrequently enough given publicity to lend an aspect of novelty to the article in this issue on the Harris-Newmark building in Los Angeles. This was an operation completely typical of city conditions—a building on heavy traffic streets with no space outside its walls for materials or construction operations. Almost, it seemed, there were no alternatives for the contractor; to get his materials into the building as he could manage and there work them up as best he was able, of their mere selves, seemed enough of a task without searching for economic refinements of routing and manipulation. In disclosing the error of this assumption lies the fundamental value of the article. It proves that here under the most restricted conditions with freedom of action curtailed in almost every direction, there was an economic choice of plant location, plant units and routing of materials. It proves that there was not only one but several alternatives free to the contractor and that it required only technical acumen and search to find them and to choose that which seemed the best. These lessons transcend any other value which the analysis offers outside the specific case for which it was worked out.

A Fruitful Traffic Survey

SELDOM has a traffic survey materialized as a definite road construction program so quickly as in Cook County. This county, with its great city of Chicago, undertook late in 1924, with the counsel and the aid of the Bureau of Public Roads, to determine by survey the nature of its traffic problem. The report of the findings and the actions taken to meet the demands which they showed to exist has recently been published. As a matter of news this publication is late—the improvement program and indeed the actual road construction antedate the report by more than a year—but it gives for the first time the official record. And it is a notable one. Aside from the technics of the survey methods and the analysis of the results there is major interest in the fact that investigation has been translated immediately into constructive action. This required the co-operation and co-ordination of the U. S. Bureau of Public Roads, the Illinois Department of Highways, the Cook County Highway Department and the Chicago Plan Commission, four agencies having separate and partial jurisdiction in any unified regional road system, in a common program. In substance agreement was arrived at and construction was inaugurated in a few months. Today Chicago and Cook County are "set" on a regional plan of highway and street improvement which promises a relief in traffic congestion that goes beyond anything contemplated in other than a few communities. The significance of this fact lies in the inspiration which it gives other urban and suburban regions of heavy intercommunicating travel. They can do as much by the same means that this report of the Cook County traffic survey explains so clearly.

Mechanizing Building

CONVICTION that building construction has lagged in employing labor saving machinery is being rather commonly expressed. Indeed much of the criticism is censorious. A fraction is palpably irritable. General dearth of skilled workmen at the peak demand and the grip of organized labor on the building trades have created a fractious attitude of mind. It is a natural enough condition, but constructors should not let it carry away their logic or knowledge of technical facts. Skilled labor predominates in building construction. Common labor holds the rank in most other engineering construction operations. The opportunity to substitute mechanical for manual operations in these two classes of labor is quite different and the economy of doing so vastly less certain in the case of skilled labor where nicety of manipulation and not output volume is chiefly required. But as conditions are, there is no lack of evidence of the mechanization of building construction operations. Virtually all carrying and hoisting is machine performed. Concrete mixing and placing is largely mechanical. Pneumatic tools have revolutionized the assembling of steel frames. The job saw mill takes much of the form construction away from the carpenter. And, a fact which is not always counted to the credit of mechanical processes in building, mill-built units are many and are constantly increasing in number and mounting in size. These facts are not reasons for resting content with the present mechanization of building operations; instead they are encouragement for further invention, but they dismiss much of the hypercriticism which on occasion is being heaped on the building constructor. Let the machine designer not despair that his invention, if worthy, will fall useless by the neglect and lack of enterprise of the professional builder.

Using Nature Best

EVERY so often a great furore is raised by "nature-lovers" because of the invasion of some natural beauty spot by the utilitarian hand of the engineer. Hetch Hetchy, bringing water to a great city, is denounced as the ruination of a garden valley, or a proper development of New York State water power is blocked by an unreasoning clamor for damless rivers. Happiness for the majority, the obvious proper end of life, is assumed to lie in certain superficial aesthetic satisfactions. He who would destroy them or even utilize them, no matter to what end, is an enemy to the spiritual development of man, the devil's advocate of materialism. Engineers, of course, know how false is such theory, but they do not often have a chance to demonstrate its falsity to its disciples. It must have been some satisfaction, therefore, to O. C. Merrill, the executive secretary of the Federal Power Commission, to be able to do so at the National Conference on State Parks last Monday at Hot Springs, Ark. Mr. Merrill there made it plain to such "nature lovers" as were present that there are larger and wider spiritual gratifications than the sight of a waterfall or the peace of the big woods and that quite conceivably more people might gain more happiness through the cheap and widespread distribution of power from a mountain stream that from merely looking at it. Utilization of these lovely natural resources, he indicated, is not necessarily the gross commercial endeavor it is so freely assumed to be; it may be, and generally is, a private, or even a public, concentration of effort for the communal good, in the forwarding of which the promoters profit only as the public does. Too often these truths are forgotten, too often a selfish sort of primitivism is glorified into something desirable by those who see in anything practical only something profitable to the few. A little study of the interweaving of society would soon show that nature may serve best when it serves through man's mechanisms.

Construction Textbooks Wanted

COURSES in engineering construction are announced by a number of the state universities, due probably to the increasing notice given to construction as an industry. Whatever its impulse there need be no apology for the action. If excuses are in order they are demanded rather by the fact that it has taken so long to start in our engineering schools real training in construction methods. It is not forgotten, in making this assertion, that college engineering courses have some touch of construction but it is construction in the sense of composition of structures and definition of materials and only slightly construction in the sense of means for and methods of fabricating structures. In this latter phase or part of construction lies the new task for the technical schools, and they find themselves confronted with the difficulty of having scant text for teaching. Last winter at the road conventions at Chicago both contractors and educators testified to the lack of books which treated on the technique of construction. The fact has to be admitted. There are writings, indeed a vast volume, but there are few treatises or manuals which assemble and co-ordinate the information on construction technics. On construction economics somewhat better has been done by a little group of writers but the field lacks much of being occupied. Without text, as they pointed out at Chicago, instructors are handicapped, for they have not, and generally cannot have, the range of experience which equips them to instruct from their own knowledge. Today the library shelves are virtually bare of usable texts on construction. It is the task of practical constructors to fill the vacant space. Until they do they may not jibe at the theoretical instruction, or no instruction, in construction now had by pupils in engineering schools.

Greater Community Needs

COMMUNITY needs are growing to gigantic proportions. No more striking demonstration of this truth could be found that New York's new subway system, whose general planning is outlined in this issue. The undertaking is beyond precedent in magnitude among municipal works; yet its purpose is not to provide a new service, but merely to extend a service already existing.

In building its third rapid-transit system the metropolis of the Western world is incurring a cost greater than city, state or nation ever before has faced for any single peaceful undertaking, unless perhaps the kingdom of the East surpassed this financial venture at the time when it built its Great Wall, many centuries ago. To measure it by modern undertakings: the cost of the new 57 miles of city railway now under construction would build a complete transcontinental railroad, or another Isthmian canal, and still leave a balance.

There is a broad significance in the huge cost of the enterprise. Many battles have raged around the project since the first planning was entered upon seven or eight years ago; even today there are contentions about it, as for instance concerning the financial program. It is more than probable that when the system is completed, we may look back and discern a loss of time amounting to five or ten years in its final realization, due to the delay resulting from such contentions. This same condition characterizes every modern public service undertaking of magnitude. The basal cause is that general understanding of community investment needs develops very slowly, and lags far behind the growth of the physical need itself.

The public is apt to stand aghast at cost estimates for great works, even long after there is clear proof of their absolute necessity. Engineers themselves exhibit to a surprising degree this reluctance to think ahead in large money units. In the New York district itself, for example, the estimate for an arterial bridge across the Hudson River, and still more recently those for suburban commuters' transit lines to west and north, have been received with unbelieving apathy, because of the startlingly high cost figures, and engineers voiced this feeling more outspokenly than did men of the general public. The same phenomenon is exhibited in other communities—for one thing at Chicago, where the cleaning of the Augean stable of antiquated sewerage has often been decried as impossible, because of its great cost.

We need in many ways to free our minds from the fettering habit of thinking too timidly about community investments. When we appreciate better that huge outlays of money are necessary to keep our community machinery in a state of decent efficiency, we will be able to make faster progress. To this end it is helpful to reflect on the outlay of some five hundred million dollars for an additional subway rapid-transit line in New

York City. It can serve to quicken our understanding of the urgency of large enterprises for public service.

There are other aspects of this great rapid-transit project that invite serious reflection. A new and impressive example is furnished of the dominating position of transportation in the life of large cities today. The pressure of street traffic problems has already taught us much in this direction; yet it is probable that few fully recognize that the modern city—small as well as large—rests quite as much on a basis of internal passenger transportation as the cities of the middle ages existed on a basis of defense against outside attack. Just as the old-time city could not long survive, or at all events could not flourish commercially and industrially if it were not possessed of most impregnable defenses, so there can be no great future for the modern city that neglects to develop its facilities for free movement of its people. The courageous replanning of thoroughfares, widening of streets, and cutting of new ones, that has been carried out in some cities evidences that recognition of this truth is not uncommon. But so rapid is the evolution of transportation demand in recent times that even the most active efforts in street improvement have nowhere even remotely approached the needs.

How city development is hampered by limits fixed many generations ago also has a profound reaction on the New York rapid-transit situation. The city is approaching the point where the street space available in its central district will no longer suffice. Certainly no more rapid-transit facilities can be compressed into the narrow central belt of Manhattan, along which its governing authorities have ever centralized its transit arteries. Room is still available along the eastern and western borders of the island, but to utilize this space will mean extensive outward spreading of those elements of business now concentrated along the axis, coupled with much more extensive development of transverse transportation than has yet been attempted—altogether a wholesale readjustment of the city.

Decentralization holds out one hope for relieving transit conditions and reducing the cost of city passenger transportation. Unfortunately, it is a most difficult doctrine to popularize and to apply. Equally unfortunate is the fact that no one definitely knows how it would result—whether it might not increase the total amount of transportation required more than it would decrease its concentration. Another possible remedy lies in the evolution of better methods of passenger transportation. At best the present types of rapid-transit railway, with widely spaced, infrequent transportation units, have a low efficiency. But the development of new rapid transit methods, if such may be found, is still in the future.

The plans for the new New York system show with only minor variations a close duplication of the system planned thirty years ago. Although a vast amount of planning has been done on transit problems in the intervening time, it has not succeeded in bringing to practical application any method differing substantially from that known and put into practice in the nineties. Aside from the as yet imperfectly worked-out system of continuous trains, nothing has been offered in the meantime to permit of realizing materially higher passenger capacity than the conventional system, embodied in its highest form in the lines now under construction.

Returning to the subject of the huge expenditure involved in the new subway system, it is remarkably interesting to learn that the system will pay. With a fare below 10 cents, the traffic that is assured will easily and dependably pay the whole cost of amortization as well as operation, say its planners. However, provided a proper charge can be placed on the unearned increment of value of the property along the new lines, which will soar in price through their construction, the system will pay on a lower fare, even on 5 cents. In this view of this case, account is taken of the fact that fully half of the cost of the structure of these subways represents extra expense due to congested city conditions. It seems fair that the property creating these conditions, which is saved from depreciation and in addition is made more valuable by their construction, should contribute to their cost. If this due charge can be taken care of, a 5-cent fare will take care of the remainder of the cost, even at the present-day price level, and even under the extreme long-haul conditions of New York City transportation. Thus, the tremendous daily flux and reflux of the population of a large city accomplishes a financial magic greater than most activities of world-wide scope and import.

Government's Place in Industry

SOME one, by report the late President Harding, originated a few years ago the phrase, "Less government in business, more business in government." As a slogan for a march against a dangerous tendency toward communism or government ownership, this was very appealing. The sentiment it expressed has been well carried out in our national administration for the past five years, but like all political issues, the pendulum may swing too far the other way. There has arisen now a school which apparently would in its opposition to communism set up almost anarchy. That is, in its true definition, absence of all government. They not only resent the undue activities of government in the actual doing of things which can best be done by private enterprise, but they attack the interest the government shows in the conduct of business. To such extremists there is no apparent need of government at all, except possibly for the collection of such negligible taxes as they seem to think would result if their program were carried through and for the minor details of police administration. Such gentlemen would do well to sit down some day and read up a little on economics. They might, for instance, go over a new book on economics just published by Prof. Edie, of Indiana University. They will find there, for instance, that this unprejudiced student of economics lists three basic factors in production, land, labor and capital. This is the classic subdivision, of course. But he lists further three auxiliary factors, management, government and money, and he has this to say regarding the second of these auxiliaries: "Government is not a burden on industry but is just as indispensable a factor in production as land, labor or capital. Government is a form of labor. It renders economic services necessary to modern production. By protecting property rights, enforcing contracts, regulating competition and rendering a wide variety of economic functions, government creates utilities, contributes to the making of physical products and supports the making of money profits. Government is productive enterprise in the truest sense of the word."

New York's Third Subway Under Construction

New Lines to Connect Four Boroughs—Duplex Trunk Line Through City and Feeder Lines to Five Outlying Districts—Complicating Features of Track Arrangement and Local Conditions—General Types of Construction

(A two-page inset plate accompanies this article.)

Beginning a series of articles on rapid-transit subway construction now in progress in New York, where a complete new network of lines is being added to those built in 1900-1904 and 1913-1918. This article outlines the planning of the new system and the reason for the leading departures from the design of the earlier subways. Outstanding features of construction will be described in later articles.

CONSTRUCTION of a third general rapid-transit subway system was begun by New York City within the past year and is proceeding under high pressure. Contracts for about $100,000,000 of construction have been let to date. This undertaking is one of the most remarkable governmental construction enterprises in history, its cost being greater than that of any other single municipal undertaking known. Its fixed structure will cost more than $400,000,000, and nearly $200,000,000 will be required for equipment and other expenditures. The system reaches out into four of the five boroughs of the city and will about double New York's subway facilities.

Many remarkable features are found in the work apart from size and cost. Present-day conditions make much more severe demands on the subway designer and builder than those of 25 years ago, when the first subway line in the city had just been put under construction. Natural and artificial obstacles — underground structures, narrow streets, crossings with other subways and tunnels as well as with aqueduct lines and large sewers—control the design at a great many points, and the location planning and structural design involve formidable problems in consequence. Special considerations of operating flexibility and of the passenger's convenience led to the adoption of a track arrangement involving several cases of complicated interweaving of tracks by over and undercrossings. Two-level construction is required in a number of streets, and three levels occur at several crossings. These and other comparisons with earlier subway work give the present system special technical interest.

Growing Traffic Demand—Rapid-transit demand in New York City has grown steadily since the first subway lines were put into operation in 1904. For about 25 years prior to that time, the city had been served by elevated railways, which through gradual extension had increased to about 82 miles of structure, carrying about 194 miles of track. The subway system added 23 miles of structure with about 70 miles of single track, extended within the next few years to a total of 76 miles of track. At that time, the elevated railways were operating at an extreme congestion in the rush hours, a condition made worse by the interference caused by change from steam locomotives to multiple-unit electric cars, then in progress. The new subway lines, however, reached a substantially similar condition of crowding within five or six years, and long before 1913, when the second system of subways was placed under construction, conditions had become intolerable. This second system, totaling 102.2 route miles (partly subway and partly elevated) or 341.7 single-track miles, was much delayed in completion by the war; in consequence, when it was opened to traffic in 1918, it relieved conditions for only a short time, and soon was as fully taxed by the growing traffic as the old lines.

It was at once evident that an immediate beginning should be made on further extension of the system, not only to relieve existing traffic congestion but also to open up new suburban residential territory to permit spread of the population. Moreover, the city's business habits had in the two preceding decades largely readjusted themselves on a rapid-transit basis, as the great decrease in surface-car traffic made evident. Thus, the growth of rapid-transit demand was dependent not only on increase of population and built-up area, but also on increased rapid-transit demand per capita. Present rapid-transit traffic is about 270 rides per capita per year, as against 180 surface-car rides per capita (total rides 450 per capita). Of the rapid-transit traffic about 60 to 65 per cent is subway and the remainder elevated.

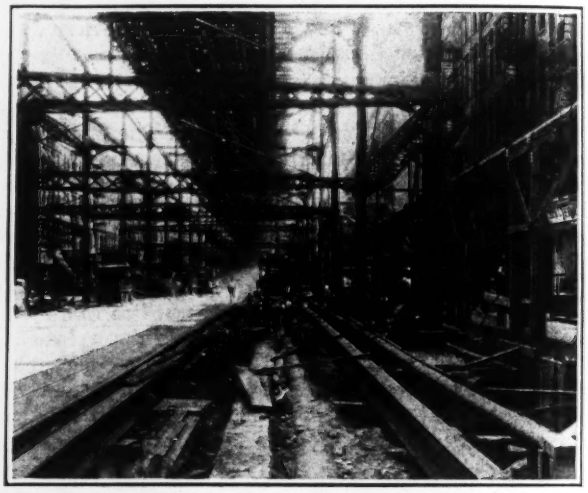


FIG. 1—STREET CONDITIONS THAT MAKE SUBWAY WORK DIFFICULT

Under the high elevated-railway structure in Eighth Avenue near 116th St. The subway is being built directly under this structure, one line of elevated columns resting on the subway roof. First opening of street shown; at present the structure at this point is nearly finished.

Under the pressure of the obvious demand, planning for rapid-transit extension went on in various forms and in the face of many financial and political difficulties, until two years ago, when the city authorities agreed on the Central Park West line, one of the important elements of the system now being built. Continued planning finally led to the adoption, in May, 1925, of a comprehensive system composed of a double trunk in the midtown section of the Borough of Manhattan with five

arms reaching out, respectively, to Upper Manhattan, western Bronx, southern and central Brooklyn, and the Queens-Jamaica region. With but minor modifications, mainly in the arrangement of lines serving the central Brooklyn area, this is the system now being built.

General Routing—When the earlier subway systems of New York were laid out, the business center responsible for creating the traffic peaks was located on the southern tip of Manhattan Island, south of City

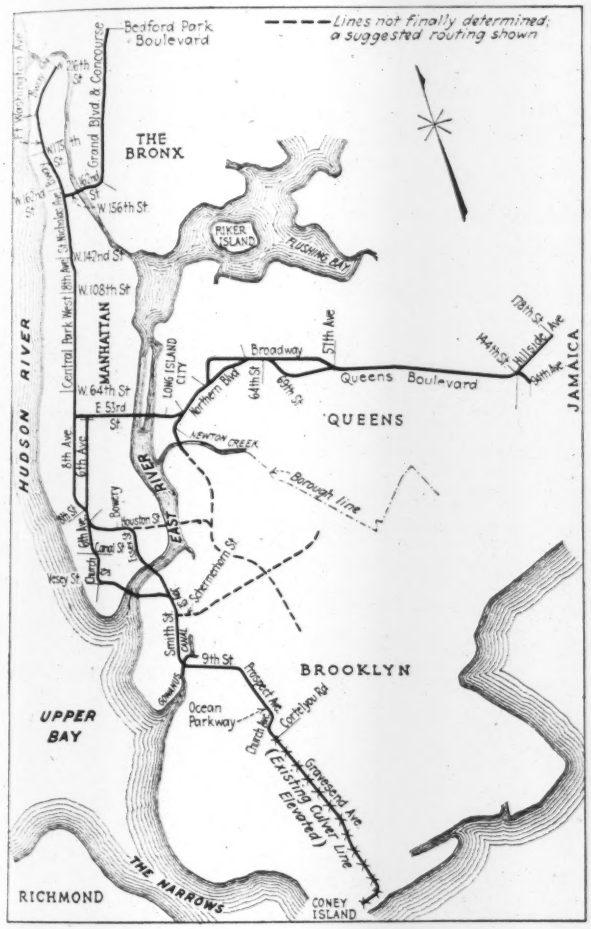


FIG. 2—ROUTES OF THE NEW SUBWAY SYSTEM

Some of the Brooklyn and Queens lines are not yet definitely fixed as to route. The dotted lines show one location that has been suggested.

Hall. Since then development of the midtown section, 23rd to 59th Sts., has made this section, relative to traffic, an important competitor of the Wall St. section. The shift of business location and daytime activity has an important influence on the layout of the new system, as reflected in the system map, Fig. 2. Whereas in the earlier systems the lines from Brooklyn and from the northern parts of Manhattan and Bronx Boroughs led as directly as possible to the Wall St. neighborhood, where the principal distribution and pick-up of passengers was looked for, the new system centers in a double midtown trunk line extending from 53rd St. south to 8th St., through Eighth Ave. and Sixth Ave.

This arrangement was adopted in spite of the remarkable difficulties faced by additional subway construction in Sixth Ave. The street is already occupied by an elevated-railway structure; below ground is the double-track subway and tunnel line of the Hudson & Manhattan Ry., and in the worst section, extending from 31st to 34th Sts., there cross the Broadway subway line of the B.M.T. system and (considerably deeper down) the crosstown tunnels of the Pennsylvania Railroad in 31st and 33rd Sts. At this crossing point, therefore, the new Sixth Ave. subway must be placed at such depth below surface that it will pass over the Pennsylvania tunnels and under the other two subways.

At its northwest corner the double trunk line, united by a 53rd St. link, connects with the Central Park West line already mentioned as the first to have been determined upon. This line extends up Central Park West, Eighth Ave. and St. Nicholas Ave. to 156th St., branching thence (1) eastward to a tunnel crossing of the Harlem River and through 162nd St. to the Grand Boulevard, along which it extends north to Bedford Park Boulevard, and (2) north through St. Nicholas Ave. and Fort Washington Ave. to the Harlem River ship canal—the northern end of Manhattan Island, within about three miles of the northern city line.

The north end of the midtown trunk section also has an easterly connection in 53rd St. with a line extending across the East River and some 10 miles east to Jamaica, running mainly through Queens Boulevard and Hillside Ave., principal traffic arteries of the central part of the borough of Queens. Much of this line taps territory now lacking rapid-transit service, though well crossed by lines of the Long Island R.R. The latter road has for some years past complained that its terminal facilities are insufficient to care for the traffic originating within the city, and has urged that the city should provide its own rapid-transit lines to deal with this traffic. The new Jamaica line as well as the Flushing extension (just being completed) of the present Queens elevated lines will take care of this difficulty.

At the south end of the midtown section two other lines lead southward and eastward respectively, branching from a short eight-track section developed by the meeting of the Sixth and Eighth Ave. lines. The southerly route passes down along Sixth Ave. extended (not yet opened up) and Church St. to Fulton St., turning here to cross the East River to a junction with the easterly branch, which traverses the densely popu-

TABLE I—MILEAGES OF OLD AND NEW RAPID-TRANSIT LINES IN NEW YORK CITY

		Company Owned		Successive Totals, Co. and City Owned		City Owned			Successive Totals, City Owned		
		Route Mileage	Track Mileage	Route Mileage	Track Mileage	Route Mileage	Track Mileage	Cost	Route Mileage	Track Mileage	Cost
To 1900	I. R. T.	37.7	92.9	.....	.....	.....	.....	.....	.....	.....	.....
	B. M. T.	44.7	100.7	82.4	193.6	.....	.....	.....	.....	.....	.....
1900 contract 1		.....	.....	104.4	260.3	22.0	66.7	$54,500,000	22.0	66.7	$54,500,000
1902 contract 2		.....	.....	108.0	269.6	3.6	9.3	6,700,000	25.6	76.0	61,200,000
1913	Contract 3	4.3	26.2	.....	.....	48.6	146.2	155,000,000	.....	.....	.....
	Contract 4	8.9	52.8	210.2	611.3	40.4	116.5	170,000,000	114.6*	338.7**	386,200,000
1925 new city system		.....	.....	267.2	781.3	57.0	170.3	405,000,000	171.6	508.7	791,200,000

*Includes 47.2 route miles of elevated structure. **Includes 133.5 track miles of elevated structure.

lated lower East Side. Two extensions into Brooklyn extend eastward along a main population axis, and southeastward to a junction with the existing Gravesend Ave. elevated-railway line of the B.M.T. system, which under the city's contract with that company may be recaptured and integrated with the new system.

Track Arrangement and Crossings—With a view to developing full capacity of all the main tracks of the system, the branching and crossing points have in general been developed by the construction of diverging subways which cross over or under the main tracks. The extent to which this is necessary may be appreciated from the condensed track diagram, Fig. 4, in which the number of tracks to be provided on the different lines and their interconnection at the junction point is indicated. This diagram at a glance reveals the key position of the midtown trunk trackage, the 53rd St. line and the Jamaica extension.

The complex crossing layouts occurring at the north and south ends of the midtown trunk section are shown in perspective drawing on the inset plate. It may be seen from these views how the intermeshing of lines serves to complicate and increase the cost of the system.

Special Track Arrangement—Most of the new network consists either of four-track or of two-track line. In the former, normally the two central tracks are intended for express service and the outer tracks for local service. However, in order to serve the public's convenience, this arrangement is departed from in certain sections; in other sections the street is too narrow to accommodate four tracks side by side, requiring double deck arrangement.

A prominent instance occurs on the Eighth Ave. line, now under contract. This line extends for a distance of 2½ miles along the west side of Central Park, and here all the tributary traffic lies to the west. Since no express-train stops are provided in this section, convenient use of the local tracks has been facilitated by shifting these two tracks to the west side of the structure (see the inset plate). At both ends of this section, the tracks are deflected over and under each other (eliminating crossings at grade) to resume normal position. Farther north on this line local tracks are above the express tracks in double-deck structure.

In general design, the new subways follow closely the practice established in the first subway system. Experience led to some important changes, however. Most of these changes were incorporated in the design of the second system, built from 1913 to 1920, and the present lines are closely similar to the latter in structure.

Important Changes from Prior Designs—In the first subway system the local stations were originally built 200 ft. long and the express stations 350 ft. long, to permit operation of 5-car local trains and 8-car express trains. Thereafter the local stations were lengthened to 225 ft. to permit operating 6-car local trains and the express stations were lengthened to from 435 ft. to 480 ft. to permit the operation of 10-car trains. In the second subway system the maximum platform lengths were 480 ft. for I.R.T. operation and 530 ft. for B.M.T. operation; the 530 ft. length permits the B.M.T. to operate 8-car trains (the B.M.T. car is about 67 ft. long, whereas the I.R.T. car is about 52 ft. long). The new system, as noted later, will have 600-ft. platforms.

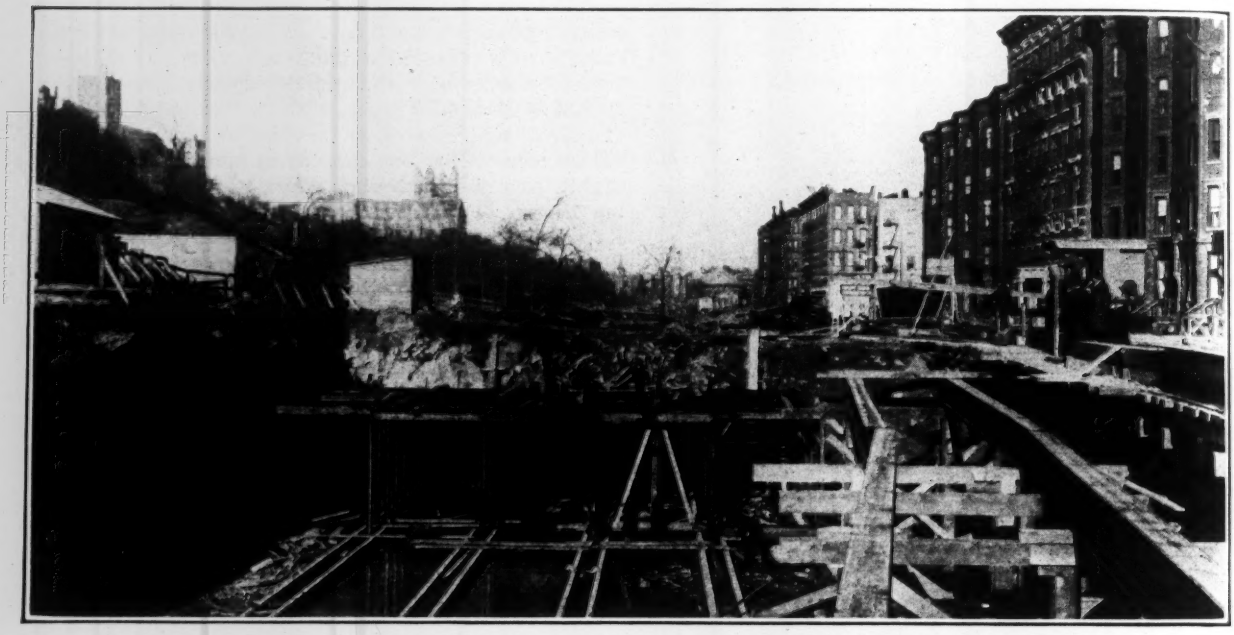


FIG. 3—STEEL-FRAME BOX CONSTRUCTION, TYPICAL OF NEW SYSTEM AS WELL AS ITS PREDECESSORS
Six-track subway structure under erection in rock cut in St. Nicholas Avenue near 131st St.

Due to the great lengths of the stations of this second subway system, the plan was initiated of having entrances at both ends of stations. In the work on the new lines two and even more controls will be provided for the stations. Long mezzanines are to be provided where feasible, with a number of narrow stairways between the platform and mezzanine, to make walking along platforms unnecessary, so far as possible.

In the first subway system some ventilation construction was added after the line was completed. In the second subway system definite provision was made for change of air, to be accomplished normally by the piston

action of trains and when necessary by fans to be used in emergency when trains are stopped. In the third or new system, this plan is being followed with only slight modification from the second system.

On the first system, ballasted track was used everywhere. On the second system ballasted track was used everywhere except at stations, where a concreted type of track was used. On the new lines it is proposed

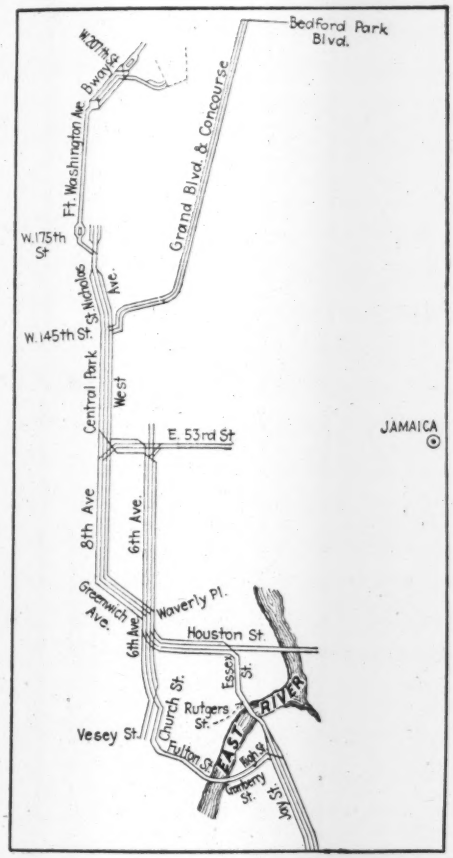


FIG. 4—TRACK DIAGRAM OF NEW SYSTEM
Brooklyn and Queens lines not shown.

to use the concrete type of track everywhere, except possibly at special work requiring ballasted track.

Intense study has been given to avoiding delays in train operation due to track layouts. To reduce to a minimum delays due to transfer, a greater number of express stations are located in the midtown district. In order to get wider platforms within the limits of the 100-ft. streets, tandem stations are to be built at certain strategic points. By this means platforms from 30 to 36 ft. wide will be possible at the 42nd St. station on Eighth Ave., instead of the more usual 22 to 24-ft. width. The southbound platform will extend south of 42nd St. to 40th st., and the northbound platform north of 42nd St. to 44th St. A mezzanine will extend over the entire structure from 40th to 44th Sts.

General Structural Type — Rectangular steel-frame box construction, as used in the first subway system, is retained as the general type. Experience has shown it to be satisfactory in all respects, well adapted to speed and convenience of construction, and free from service troubles or the development of weaknesses. Where the line is at considerable depth below the surface in solid rock concrete-lined tunnels are used, and at river crossings circular cast-iron-lined shield-driven tunnels.

The normal structure, exemplified by a drawing on the inset plate, is somewhat larger than the first subway line and part of the second. The dimensions originally used were 13 ft. clear height from base of rail and 12 ft. 6 in. track spacing. In the lines of the second system, the clear height was increased to 13 ft. 2 in. (except for 15 ft. in Fourth Ave., Brooklyn, and in the Center St. loop), while the track spacing on the lines of the Brooklyn company (B.M.T.) of the second system was increased to 13 ft. 6 in. to admit larger cars. These dimensions of 13 ft. 2 in. height and 13 ft. 6 in. track spacing are used also in the new system.

The framework consists of steel transverse bents, with columns in the side walls and between tracks carrying a transverse roof beam 18 to 24 in. deep in single-track lengths. The columns rest on concrete pedestals formed into continuous longitudinal footing walls under each row of columns. However, where the floor of the structure is below ground-water level, the floor is designed as a reinforced-concrete slab of sufficient strength to resist hydrostatic pressure and to distribute the loads of the structure through substantially the entire floor area. The typical roof-load distribution assumed in the design, as well as the size and axle loading of the typical subway cars are indicated on the inset plate.

Design Loading and Stresses—A statement of the essential design data was given in unusually informing manner recently before the Municipal Engineers Society of New York by A. I. Raisman, Division Engineer in charge of design for the Board of Transportation:

Subway Loading—The subway is in general designed to carry the dead-load above it and a live-load of at least 600 lb. per sq.ft. Under the roadway the structure is made strong enough to permit the operation of 100-ton trucks with axles spaced 12 ft. centers and with wheels of 6-ft. gage. The specifications provide that the structure be sufficient to carry the heaviest trolley cars—the maximum being the 50-ton ash car, 38 ft. long. The 100-ton truck in general gives greater loading than the trolley car. The assumption is made that the pavement distributes the wheel load over an area of 2 ft. x 2 ft. and that the load is spread out through the earth below at an angle of 30 deg. with the vertical. As a result of a study of this matter it is found that a loading of 1,500 lb. per sq.ft. to include dead- and live-load is a good compromise figure for depths of cover up to 9 ft. from the underside of roof to the street surface, and that is the usual basis of design.

This live-load has been considered rather high by some engineers who are used to the design of bridges. I recall that in the Cambridge subway a live-load of from 200 to 300 lb. was considered sufficient. The most direct illustration to combat this position is a picture showing brick or other building materials piled up 8 ft. or 10 ft. high in front of a building under construction. This represents a loading of 1,000 to 1,200 lb. per sq.ft. It is thought that the use of a street should not be limited by reason of the construction of a subway beneath it.

It might be interesting to state here that when the first subway was built the assumed live-load was varied, depending upon the character of the neighborhood. The section north of 59th St. was expected to remain entirely residential and a live-load of 500 lb. was considered sufficient. South of 59th St., in the "medium" business districts, the center spans were designed to take a loading of 690 lb. and the side spans 950 lb. per square foot. In the heavy business districts the center spans were designed for 1,000 lb. and the side spans for 1,135 lb. per sq.ft. These heavier loadings for side spans were assumed to provide for falling walls of buildings due to fire. However, the assumed live-loads were reduced as the cover increased beyond 5 ft., which was the depth usually sought. It is believed that the present assumptions are satisfactory and should be continued. At least the distinction between residential, medium

and heavy business districts was completely upset by later growth.

A fiber stress of 20,000 lb. per sq.in. is permitted for steel in bending. Where the compression flanges are firmly embedded in concrete so as to make practically a reinforced-concrete structure a stress of 25,000 lb. is permitted. In columns the permissible stress varies in accordance with a straight-line formula with a maximum of 14,000 lb. per sq.in. These high stresses are permitted in view of the very heavy loads that are assumed. However, it should be noted that it is the present-day tendency to increase the allowable stresses. The American Society committee recommended an increase from 15,000 to 20,000 lb.

Here it might be of interest to note that on two or three occasions, as the result of derailment, from two to six intermediate columns have been knocked out, without apparently doing any permanent damage to the subway. The beams or girders are not in general spliced over the columns to transmit bending, but when the columns were gone the roof remained stationary in spite of our usual ideas on the subject. The natural assumption is that an arching effect took place in the pavement, in the earth fill with its pipes, etc., and also in the steel and concrete of the roof, which carried the load over to the adjacent solid supports. Naturally also, as soon as the accident occurred the street traffic was roped off of the area above and speedy efforts were made to put in temporary supports.

The track loading from subway trains amounts to about 1 ton per linear foot of track.

The steel framework as described contains no longitudinal steel members except at stations. The bents thus are quite independent, which is held to be an advantage in construction, as it permits a considerable variation

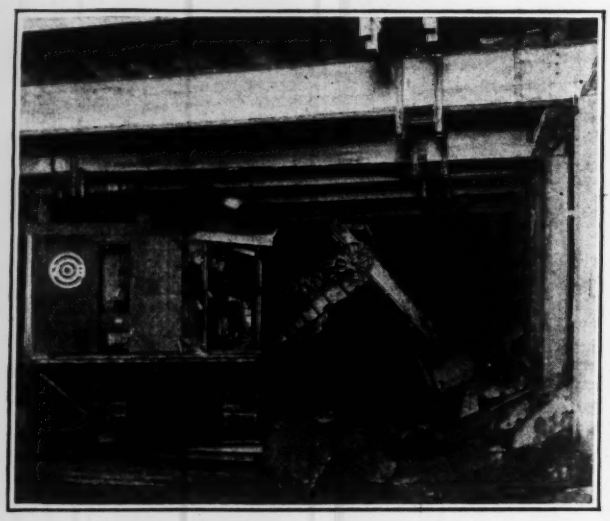


FIG. 5—SUBWAY CONSTRUCTION FACILITATED BY MODERN MACHINERY
Power shovel excavating under timber street deck.

of the position of bents if local conditions make this desirable. The side walls and the roof are formed of jack arches of concrete between the columns and the transverse beams, with crown thickness of 7 in. Waterproofing (used only on the roof and below water level) is applied outside of this thickness and in turn is protected by a layer of concrete or (where the water pressures are high) by 4 to 8 in. of brickwork laid in mastic. These features of construction are substantially identical with those of the first subway. However, the kneebraces then provided to stiffen the connection of roof beams to columns are not used in the present design, and the bulb-angle columns of the first subway are replaced by built I-columns of plates and angles.

Concrete partition walls are built between tracks of opposite traffic direction (except at stations, crossovers and other special points). Near switches a wall is also constructed in the intermediate column line, for protection to the structure in case of derailment. The central partition wall was not used in the first subway

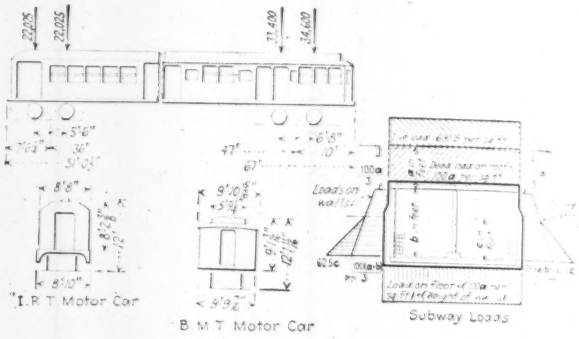


FIG. 6—ROOF-LOAD AND CAR DIAGRAM

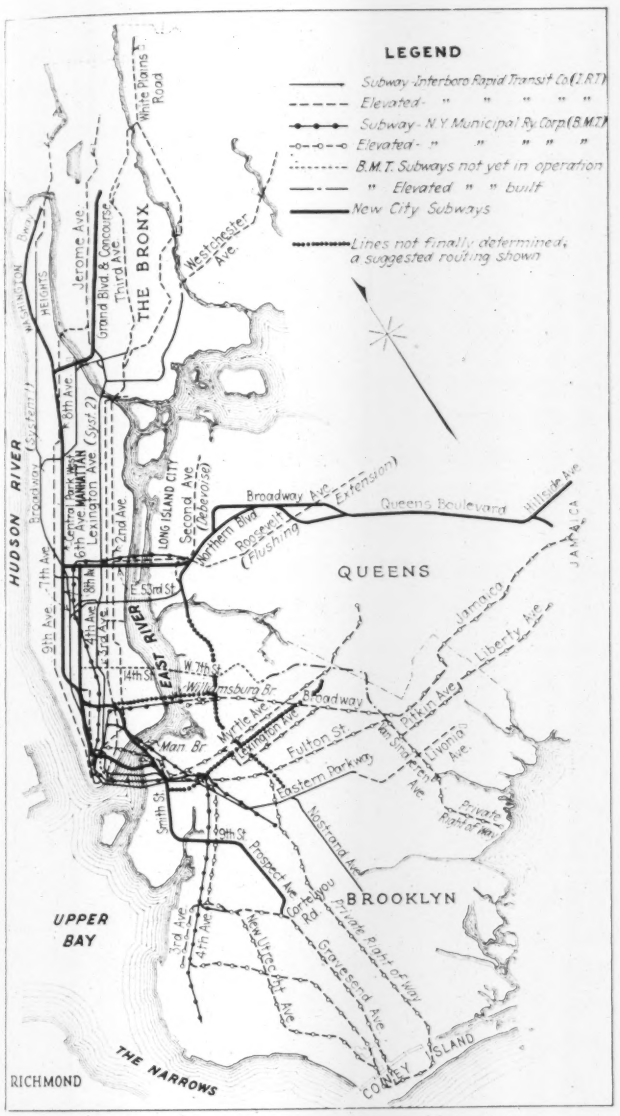
system but was adopted in the second, as an aid in ventilation, to make the piston action of the trains effective in moving the air toward the ventilation outlets.

Duct benches about 2 ft. wide and 4 ft. high are constructed along either side wall, extending to car floor level. The top of these benches is available for use as a walk in case of an interruption to train service, when passengers must be allowed to leave stalled trains. These benches increase the width of the structure only slightly, as they can be built close to the car clearance line or about 5 ft. 5 in. from track center, which is 13 to 18 in. less than the required side wall clearance.

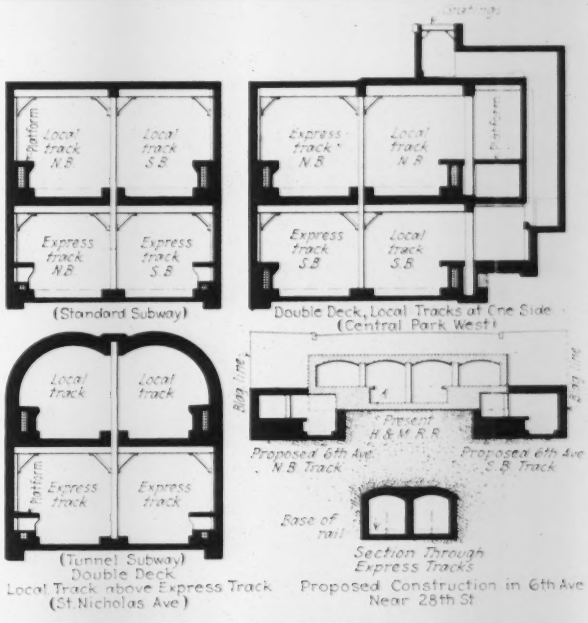
A complete system of ventilation inlets near the stations and outlets with exhaust fan chambers midway between stations is provided just as in the second subway system. The absence of adequate ventilation provision in the first subway system led to much trouble from excessive heat in the subway atmosphere in summer, and this was the reason for the design of the ventilating facilities in the second system. It has been found entirely successful and is retained in all essentials. Change of air every 15 min. is desired, requiring usually about 800 sq.ft. of openings at each station and midway between. Gratings over the openings are given 50 per cent excess area. A typical case of the ventilation arrangements is sketched in diagram plan on the inset plate.

Special Problems—Many special structural problems have arisen from the various complicating conditions affecting the new system. In Sixth Ave. it is planned to arrange the tracks of the new system alongside and below the level of the Hudson & Manhattan subway. At many points sewers, aqueducts and other subsurface structures of large size must be accommodated, for which purpose various expedients are resorted to, as illustrated for the aqueduct crossing at 92nd St. and Central Park West and two sewer crossings.

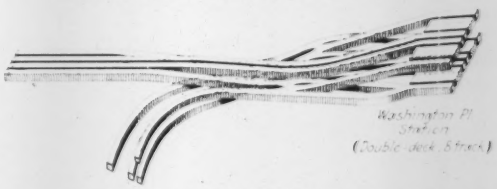
Track—Short block ties set in concrete are to be used for rail support throughout the new system, as compared with the ballasted track construction used throughout the first subway system and on most of the second system. In the latter, short block supports were used at stations, and the construction has been found so satisfactory as to lead to its adoption as standard.



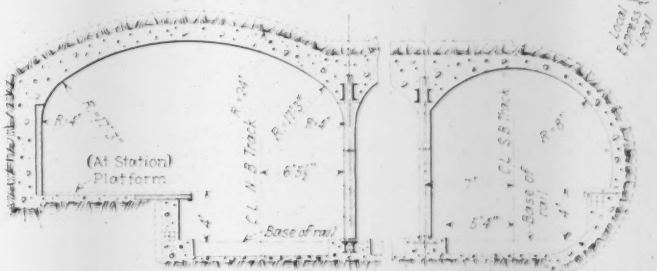
NEW YORK'S RAPID-TRANSIT LINES, OLD AND NEW



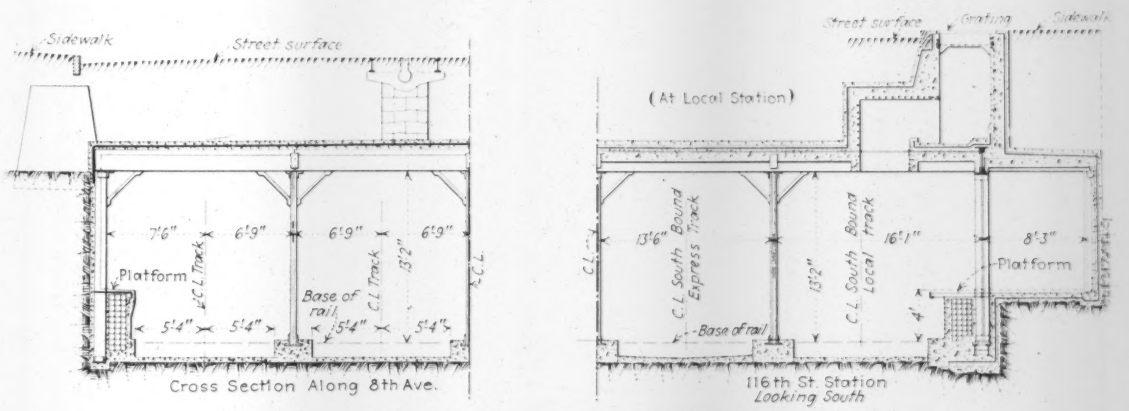
SOME SPECIAL TRACK ARRANGEMENTS



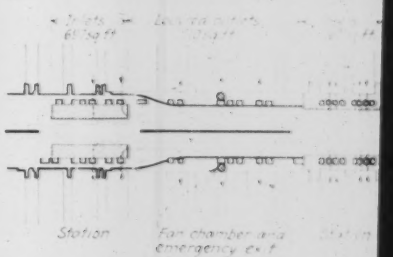
JUNCTION AT SOUTH END OF SIXTH-EIGHTH AVE. TRUNK LINES



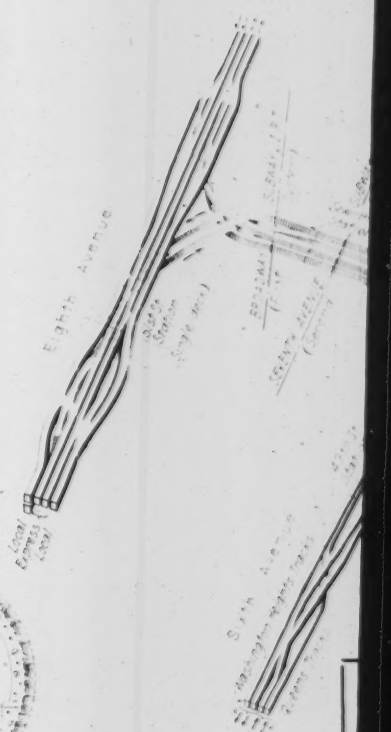
ROCK TUNNEL TYPE

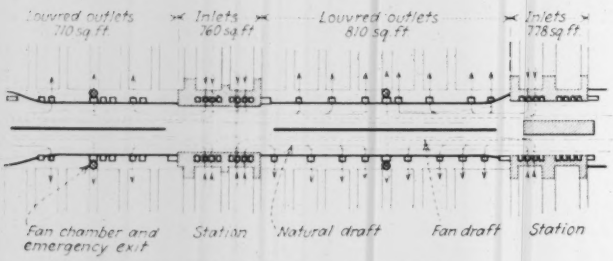


NORMAL STEEL-FRAME BOX CONSTRUCTION

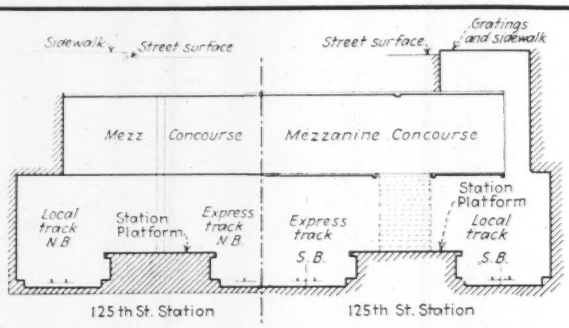


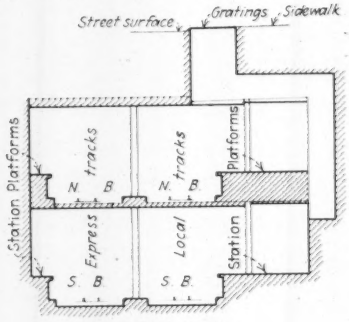
TYPICAL PLAN OF VEN

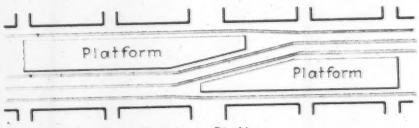


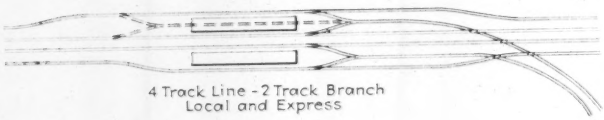


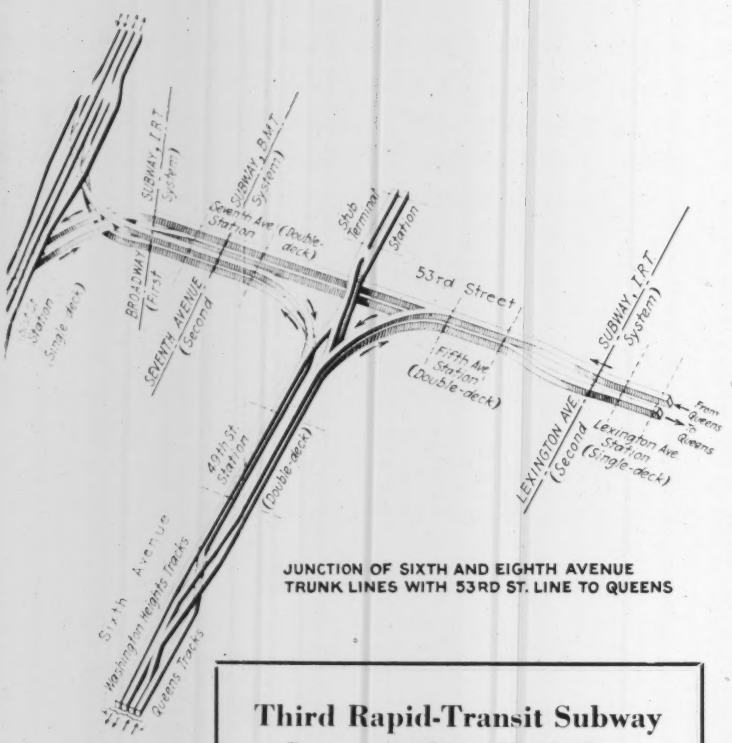
TYPICAL PLAN OF VENTILATION FACILITIES





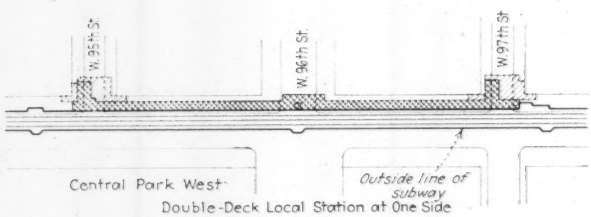




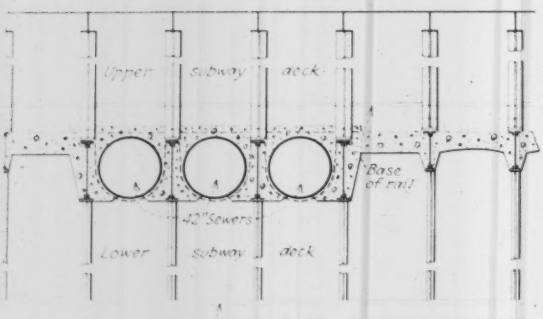


JUNCTION OF SIXTH AND EIGHTH AVENUE TRUNK LINES WITH 53RD ST. LINE TO QUEENS

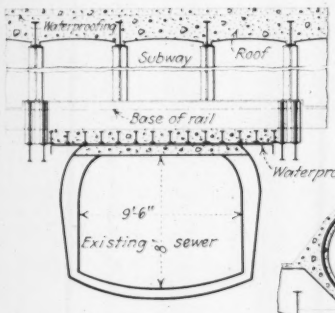
Third Rapid-Transit Subway System in New York City —Location and Typical Design Features



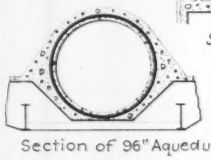
SOME TYPICAL STATION LAYOUTS



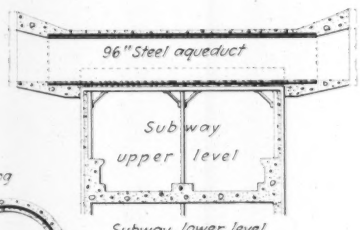
Sewer Crossing Between Subway Decks at 39th St & 8th Ave.



Subway over Existing Sewer, 46th St. & 8th Ave.



Section of 96" Aqueduct



Aqueduct Crossing Subway in Depressed Bay, 92nd St. & Central Park West

SPECIAL CONSTRUCTION AT SEWER AND AQUEDUCT CROSSINGS

Operating Plan and Stations—The general operating plan of the existing subway systems—to provide by separate tracks for two types of traffic, express and local—is retained in the new system. An effort has been made, however, to correct some of the defects of this operating plan as it has developed in practice on the older systems. The local trains now rarely carry full load or operate at maximum track capacity. Further, there is so heavy a traffic interchange between local and express trains at the interchange stations as to slow up the movement of express traffic and therefore to reduce the capacity of the express tracks. Both effects cut down the carrying capacity of the system, and both are believed to be due in part to the rather close spacing of express stations and to the fact that the station layout facilitates interchange. The new system has been designed with longer station spacing, both express and local, except that in the midtown district almost all stations are express stations, so as to avoid long transfer stops in the congested districts. A great deal of study is being given to the problem of providing commodious facilities for passengers' transfer at points where lines intersect or join.

An operating plan for the five-branched system has not been fully worked out, but it will necessarily be complex. Care has been taken to lay out the system with such track interconnections and arrangements as to suit various schedules of operation. In particular the effort has been made to avoid bringing two tracks together into one or otherwise reducing the track capacity of the system at any point. This is not everywhere possible, as where the three tracks from the Grand Concourse and the four tracks on the upper Broadway line merge into four of the Central Park West stem.

Much care has been given to station layout, with a view to both convenience and maximum capacity. Operation of the older subway lines led to repeated increase in length of trains, requiring a large amount of costly extension of station platforms. Ten-car trains are the longest now operated in express service, and six-car trains in local service. Operating engineers believe that the length of express train cannot be increased greatly without developing mechanical and electrical limitations, and that a train length of 14 or 15 cars will probably be found the maximum with present equipment. The stations on the new system have been laid out with 600-ft. platforms, capable of being extended to 660 ft., to accommodate respectively 12 cars and 14 cars of 50 ft. So far as possible no stations are placed on curves, in which respect the present practice differs radically from that followed in the layout of the first subway, whose important stations are nearly all on curve. However, track radii of 2,000 ft. or over are considered permissible at station platforms.

To facilitate train movement, any necessary crossovers between tracks are placed preferably at the leaving ends of stations rather than at the entering ends; and waiting trains are sorted for outbound tracks.

Alignment Details—In general, the attempt is made to limit curves on the new lines to 2,300-ft. radius, without transition. However, for turning sharp corners, spiraled curves down to 600-ft. radius are considered permissible, and at the tightest places radii as low as 350 ft. have been used. In the original subway radii as small as 147.25 and 180 ft. were permitted. Grades are kept below 3 per cent where possible, but this rate is exceeded at some very difficult points. In the earlier subways, maximum grades up to 4½ and 5.3 per cent occur on the river approaches.

Progressive Construction—Largely because the Washington Heights-Central Park West route was first approved by the city authorities, construction began on this line, the first work being initiated about a year ago. At the present time, 17 contracts have been let for construction, covering the entire west side of the central loop and the Manhattan stem extending north from it to Harlem ship canal. The contract prices average around $2,000,000 per track mile in Central Park West, $2,500,000 per track mile in St. Nicholas Ave. and Fort Washington Ave., and $2,750,000 per track mile in Eighth Ave., with an overall average somewhat over $10,000,000 per mile of four-track structure. These figures include station finish and roadbed, but no third rail or signals or other equipment.

In view of the great magnitude of the work required to construct the entire system, careful thought has been given to the feasibility of operating successively completed portions as integral units for the time being. The Board of Transportation believes that the Washington Heights and Eighth Ave. line down to the southern end of the present contracts in the neighborhood of Eighth St. can profitably be operated before other parts of the system are completed. This would not have been possible 20 or even 15 years ago, as the rush-hour traffic then sought the lower end of the city, but at present one-half to two-thirds of the traffic centers in the midtown section. The next work may follow on the line leading south to the Fulton St. crossing of the East River and on the 53rd St. crosstown line leading to the Jamaica connection. Operation of the initial line can be extended to these lines without difficulty.

Relation to Present Lines—The essential plan of the new system is that it shall be an independent self-contained rapid transit network. However, the design is such that it could be operated by one of the present operating companies (Interborough Rapid Transit Co., mainly in Manhattan; Brooklyn-Manhattan Transit Corporation, mainly in Brooklyn) or by a third private corporation.

Cost and Financing—The estimated total cost of the system is summarized in Table II. The estimate as well as contract prices are more than double pre-war costs.

The first subway system was built under a construction and operation contract as a result of public bidding for the entire system. The city in this case paid for the construction. The contractor built the structure

TABLE II—PROSPECTIVE COST AND EARNINGS OF NEW SUBWAY SYSTEM OF NEW YORK CITY

Cost	
Line, stations, track, yards, shops and buildings	$345,005,000
Equipment, including buildings for power system	101,000,000
Real estate for construction and equipment	24,320,000
Culver line recapture	5,800,000
New Culver terminal	640,000
Administration and engineering	30,000,000
Total, excluding interest during construction	$506,765,000
Traffic	
Passengers per year, estimated	402,000,000
Income	
From operation at 5 cent fare	$20,100,000
Other income	603,000
Total	$20,703,000
Less operating expense	13,366,500
Net operating income, available for capital charges	$7,336,500

with the aid of a number of sub-contractors, for the amount of his bid. He furnished the equipment and obtained the right to operate the line for 50 years, with a renewal privilege. The rental paid by the contractor is equal to the interest on the bonds issued for construction, plus 1 per cent annually for bond amortization.

For the second system the city entered into an operation and equipment agreement with each of two operating companies, whereby the city was to furnish the structure and the companies the equipment. Each company also contributed a certain amount of money toward the construction. Under their contracts each company was to retain a certain amount as a preferential after operating charges. Income in excess of this was to be paid as a rental to the city to an amount equal to a corresponding percentage on the bonds issued by the city for construction, and beyond this income, was to be divided equally between the city and the operating company. By reason of the heavily increased cost of operation since the war, the companies have not earned sufficient to pay their operating charges and preferentials and hence the city has received no return on its money invested in the second system. The construction was let by the city in sections to various contractors.

The new system is expected to be built and equipped entirely with city funds. The financial problem involved for the city is therefore much greater. It is a serious problem especially because the state law limits the bonding power of the city to 10 per cent of the total assessed valuation, and the available bonding capacity within this limit will not provide for more than half of the entire project. It is proposed to meet part of the cost by construction loans to be met from the city's current revenues, and the remainder by assessments upon property benefited in the areas contiguous to the new lines. According to a statement by the chairman of the Board of Transportation a few months ago, the total cost could be raised by the issue of about $240,000,000 of bonds, $187,000,000 of short-term loans, $138,000,000 of benefit assessment, and a small balance of current funds.

The cost of transportation on the new system will depend vitally on the method of financing adopted. By covering a material part of the cost of the line through benefit assessments and another part through tax funds, the values created by the new lines can be made to pay their share of the increased transportation costs arising from the expensive forms of subway construction necessitated by congested city conditions. It is believed that on this plan a 5-cent fare will make the system self-supporting. Operation and maintenance alone are estimated at 3½ cents per passenger, ranging down to 3 cents later as traffic increases.

Organization—The Board of Transportation, which is constructing this subway system, consists of John H. Delaney, chairman, and D. L. Ryan and William A. DeFord, commissioners. The work is being designed and supervised by its engineering department, of which Robert Ridgway is chief engineer. Col. J. R. Slattery is deputy chief engineer in charge of construction, and Sverre Dahm is deputy chief engineer in charge of design. J. O. Shipman is engineer of the First Division, John H. Myers of the Second Division, J. B. Snow of the Tunnel Division, H. N. Latey of equipment and operation, R. H. Jacobs of the Track Division, J. T. Kane of the Station Finish Division and A. I. Raisman of the Designs Division.

As noted above, this project is very large, involving a great deal of money, and it is not practicable to start work on the entire project at once. It is expected to let an average of $125,000,000 worth of work per year and it is hoped to have the system in operation in 1931.

Concrete Quay Built To Carry 50-Ft. Pile of Rock

Thick, Reinforced-Concrete Slab Floated on Wood Piles Replaces Structure Which Collapsed Under Heavy Load

THE KELLEY Island Lime & Transport Co. owns and operates a lime kiln on the Buffalo River at Buffalo, N. Y., using crushed stone brought in by boats and unloaded on a wharf, or rather a quay, immediately adjacent to the kilns. Late in the fall of 1924, the existing quay failed under a load of stone, the weight of the stone pushing the wall out into the river. The old structure consisted of the usual type of massive concrete dock wall with wood sheeting for the cutoff, and timber piling supposed to be driven to rock, and cut off at the water line. This dock wall was anchored to wooden anchors held by timber piles, located about 50 ft. back of the face. It has been replaced by a reinforced-concrete dock wall and heavy reinforced-concrete floor, all on long timber piles.

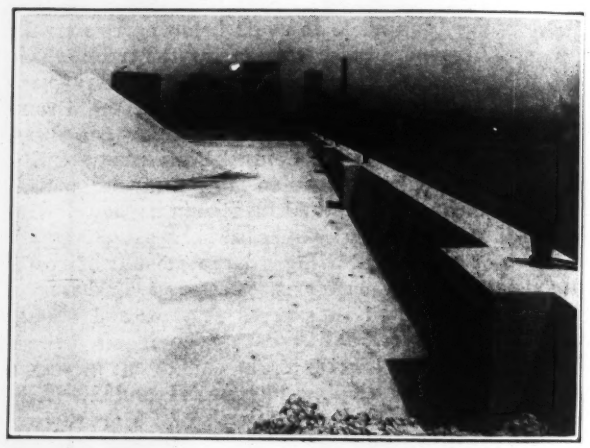


FIG. 1—QUAY PARTLY LOADED WITH CRUSHED ROCK

Borings made immediately after the failure of the old quay showed about 14 ft. of clay, then about 14 ft. of hard sharp sand overlying the solid rock, which lies from 55 ft. to 61 ft. below mean low water. Careful investigation of the conditions after the failure indicated that it was the underlying sand stratum that gave way. Possibly the initial cause of the failure was the leakage of this fine sand through openings in the timber sheetpiling, which was followed by a general slump of the ground, the pressure from the superimposed load being greater than the sheetpiling and foundation piling could withstand. Most of the old foundation piles were sheared off about 40 ft. below water.

Test piles 60 ft. long required about 200 blows of a steam hammer to drive them to rock with an average penetration of about 7 in. to the blow.

It was decided in building the new dock floor to use

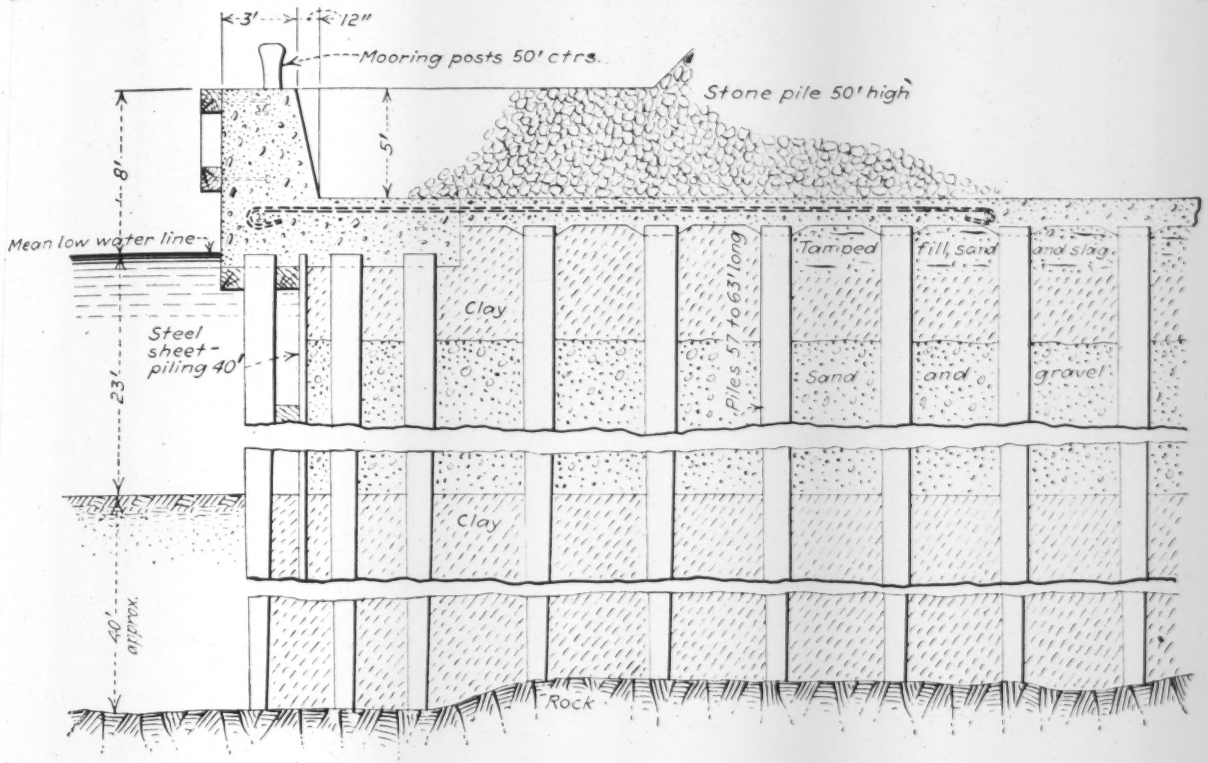


FIG. 2—REINFORCED-CONCRETE QUAY CARRYING 50-FT. LOAD OF ROCK
Built for Kelley Island Lime & Transport Co., at Buffalo, N. Y.

wood piling driven to rock and surrounded and held in place by firm sand or slag filled up to the cutoff of the pile and on this to place a 15-in. reinforced-concrete slab with reinforcing in four directions and in two planes. As this would bring a load of approximately 60 tons on each pile, assuming that the entire 50-ft. load of stone was carried by the pile and none by the surrounding soil, a load test was made on one pile, which failed at about 120 tons total load.

FIG. 3—CONCRETING QUAY FROM BARGE IN THE RIVER

In view of this heavy load per pile, it seemed desirable to make absolutely certain that the bending stresses in these piles should be eliminated which meant that the fill surrounding them must be of good firm material and that precautions be taken to make certain that this fill would stay in place. In order to accomplish this it was decided to use steel sheetpiling instead of wood. It developed later in building the dock that it would have been difficult, if not impossible, to use wood sheeting, as the steel sheeting drove very hard.

The new dock is 360 ft. long and 120 ft. in width. The top of the dock wall is 8 ft. above mean low water and the dredged depth of the river in front of the dock is 23 ft. The top of the concrete slab is 3 ft. above mean low water. Piles are driven 4 ft. between centers in both directions, under the center part, and 5 ft. between centers around the edges where the loads will be lighter. The dock wall is of massive concrete supported by three rows of piles spaced 4 ft. on centers longitudinally, the cutoff line of the piles being at the low water level. The sheetpiling is placed between the front row and the second row of piles and is of the arched web type, 40 ft. in length. Altogether 1,908 piles were used in this work, varying from 57 ft. to 64 ft. in length.

The weight of the crushed stone was assumed at 100 lb. per cu.ft. and the height of the pile at 50 ft. The angle of repose of sub-soil under water was assumed to be two horizontal to one vertical. Under these assumptions, the strength of the sheetpiling and dock wall is sufficient to withstand these pressures in case any part of the piling underneath the concrete slab should give way, transferring the load to the soil.

The engineers were Wilbur Watson & Associates of Cleveland and the contractor was the Great Lakes Dredge & Dock Co. of Buffalo.

Water-Power Developments on the Salt River in Arizona

Good Financial Status of Salt River Irrigation Project Is Due to Cheap Power for Pumping and for Revenue

THE Salt River reclamation project, centering at Phoenix, Ariz., has for many years been cited as a shining example of the successful irrigation project; the area under canals has been thoroughly settled, the land has been made highly productive and, all in all, the project has done exceedingly well. In the last few years water power has become an increasingly important factor in the financial status of the project and future plans are inseparably involved with an extensive power-development program.

While the primary objective was to develop water for irrigating land, it was obviously good business on this project to develop the power that was in part a by-product to the development of storage. The value of the power has increased, and from time to time, as it has been possible to make advantageous contracts, the value of the power possibilities as an asset has likewise correspondingly increased. In 1924 the sale of electric power produced a revenue of $650,000; in 1925, $800,000; and the estimated return for 1926-27 is $1,600,000.

This is from a power development that, with the addition this spring of the Mormon Flat plant, totals 43,000 hp. Future possibilities may be gaged somewhat from the fact that plans have been prepared contemplating a total power development on the Salt and Verde rivers of 198,000 hp. The contract recently made for all the power available from the 40,000-hp. plant now being constructed at Horse Mesa and the large power market in the vicinity of this irrigation project that is now being supplied by steam plants, indicates that advantageous arrangements can be made for selling additional power to other industrial enterprises as the various proposed power plants are financed and built.

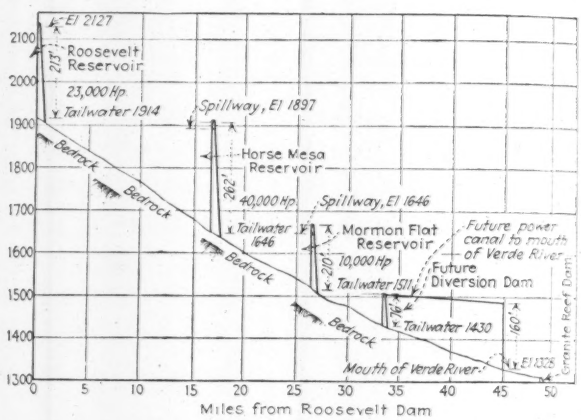
A contract made with the Inspiration Consolidated Copper Co. assures a *minimum* power revenue from the Horse Mesa project of $565,500 per annum for a period of 25 years, regardless of whether or not power is available to that extent. The terms of the contract make it entirely probable that the project will sell all available power from the Horse Mesa plant at a rate of 8½ mills, which will probably bring in a revenue of $1,000,000 per annum in normal years. This contract has an advantageous reversal provision which, in years of low runoff, will provide the district with power from the Copper company's reserve steam plant that will enable the district to supplement a temporarily insufficient water supply by pumping. Power deliveries thus reversed are billed to the Association without investment or overhead charge. Under the terms of a contract of this sort it was not difficult to float a $4,750,000 bond issue late in 1924 for the construction of the Horse Mesa storage dam and power plant.

POWER PROJECTS ON THE SALT AND VERDE RIVERS

Power (Hp.)	Location	Present Status
23,000	Roosevelt Dam	Fully developed
10,000	Valley power house	Developed
10,000	Mormon Flat plant	Developed
10,000	Mormon Flat plant	Proposed
40,000	Horse Mesa plant	Under construction
25,000	Verde River power canal	Proposed
80,000	Plants on Verde River	Proposed
198,000	Total	

The Salt River project has enjoyed special advantages in the matter of a basis for rapid development because it had a business organization already functioning before the project received government aid in 1905. Not only has the project managed its own internal affairs well—less than 0.1 of one per cent of the farmers are delinquent in their water assessments—but there has been a full appreciation of the opportunities in power development. The original generating equipment installed in Roosevelt dam in 1906 has been twice increased, the four Valley power plants were built in 1914 and one 10,000-hp. unit was put in service at the Mormon Flat dam in April, 1926. In the latter plant provision was made for later installation of a duplicate 10,000-hp. unit.

With this steady increase of power development the project management has built up a diversified market for the power. At present 30 per cent of the power developed on the project goes to mines, 35 per cent to municipalities, 15 per cent is used for pumping for irrigation outside the project, 15 per cent for pumping on the project itself and the remaining 5 per cent is miscellaneous load.



PROFILE SHOWING PRESENT AND PROJECTED POWER DEVELOPMENTS, SALT AND VERDE RIVERS

Revenue from the sale of this power has been a very material factor in lowering payments from the farmers. In the last five years the farmers have paid for their water $4.80 per acre less than the actual capital improvements to the project during this period. The total annual assessments have ranged from $2 up to $4.90 per acre, but this has been less than the amounts expended for government payments and for capital assets added. This is exclusive of the two large power developments known as the Mormon Flats project of 10,000 hp. and the 40,000-hp. development at Horse Mesa, which were financed by bond issues.

The government investment in the project was approximately $11,000,000 by reason of which the project was obligated to pay $203,000 per year up to a maximum of $670,000 per year without interest. In 1917 the project was turned over to the Farmers' Association for operation and maintenance and since then the project has paid the Government on this account $2,950,000, despite the fact that during this time there has been the most severe period of drought and general agricultural depression in the history of the project. Of the

$25,000,000 now invested in project works there is a remaining total indebtedness of approximately $13,800,000; $7,200,000 of this is without interest and is being steadily reduced by the annual payments from the farmers and by revenue from power sold.

There remains to the project the greater portion of power possibilities awaiting development and these will doubtless be developed as the market becomes available and the funds for development can be provided. The accompanying table and profile indicate the power possibilities from the Salt and Verde rivers as now projected.

C. C. Cragin is chief engineer and general manager of the Salt River Valley Water Users' Association.

Ten Years Road Maintenance Costs in New York State

Out of Seventy Millions Spent on Highways in 1925 Nearly Nine Millions Were for Surfacing and General Maintenance

ACCORDING to statistics obtained from A. W. Brandt, Commissioner of Highways, New York State Department of Public Works, a total of $40,595,010.54 was expended under the direction of the highway bureau last year. When there is added to this the $30,000,000 appropriated by towns and counties for improvement of town and county roads, the State of New York as a whole expended more than $70,000,000 to maintain or build new arteries of traffic during 1925.

Briefly the state expended for new construction of 369.19 miles under 62 contracts $16,474,781.63; for reconstruction by contract of 291.40 miles under 85 contracts $11,940,704.28; for reconstruction by department forces of 25.61 miles under 45 jobs $333,364.30. Surface treatment was given by the department to 2,287 miles of road at a cost of $1,054,826.49. General maintenance, for which a force of approximately 5,000 men is employed during the season, cost $7,806,532.91. For grade crossing elimination $644,200 was expended, while the administration and engineering cost during the year was $2,340,600.93.

Average costs of maintenance of various types of pavements in New York State covering a period of ten years prepared by David Noonan, Deputy Commissioner of Highways are given in Tables I and II. The average cost of maintenance of all highways in 1925 was $860 per mile; an average for ten years of $677 per mile is shown. The three types of pavement of which there are the greatest amount of mileage in the state cost respectively to maintain: Bituminous macadam (Penetration Asphalt), 3,617.16 miles cost $1,010.79 per mile; waterbound macadam of which 2,299.11 miles were maintained cost $999.56 per mile, while concrete, first class, 1:2:4 mix or better, cost for 2,161.22 miles $409.79 per mile.

These three classes constitute more than 85 per cent of all of the different varieties of pavement in use in this state, of which there are a total of 46. The highest priced pavement from the standpoint of maintenance cost was Roomac which cost for the maintenance of 0.15 mile at the rate of $2,232.53 per mile. Costs per mile were low in 1919 with $560, rising on an average to $631 in 1920 and $744 in 1921. In 1922, they dropped to $607, but came back in 1923 to $712, increasing to $757 in 1924 and to $860 in 1925.

There has been a steady increase in maintenance costs of the principal types of pavement during the past ten years with the exception of second class concrete which shows an increase per mile from 1916 to 1925 of only from $1,080 to $1,141 and water bound macadam which increased from $906 to $1,000. On the other hand bituminous macadam, penetration method, asphalt and tar which cost in 1916 $483 per mile for maintenance, cost $1,017 in 1925, while Topeka on macadam base increased from $256 in 1916 to $1,411 in 1925 in maintenance cost per mile.

TABLE I—COST OF MAINTENANCE IN NEW YORK OF VARIOUS PAVEMENTS BY TYPE FOR THE YEAR 1925

Compiled by David Noonan, New York State Deputy Commissioner of Highways. Figures exclude all changes to more permanent type.

Type of Pavement	Miles Maintained	Cost per Mile—Total	Pavement Only	Other Than Pavement
Bituminous macadam, Pen. asphalt	3,617.16	$1,010.79	$618.95	$391.84
Bituminous macadam Pen. tar binder	250.98	1,104.03	494.51	609.52
Bituminous macadam Pen. A conc. base	46.23	779.78	431.15	348.63
Bituminous macadam Pen. T conc. base	26.63	928.04	479.04	449.00
Waterbound macadam	2,299.11	999.56	779.15	220.41
Concrete, 1st class 1-2-4 mix or better	2,161.22	409.79	174.43	235.36
Concrete 2nd class	152.19	1,141.13	825.75	315.38
Concrete Hassam	19.45	1,228.98	905.44	323.54
Brick pavement	263.77	563.65	319.13	244.52
Gravel	111.93	1,619.04	928.80	690.24
Topeka, concrete base	80.37	597.05	299.63	297.42
Topeka, macadam base	69.87	1,410.69	836.32	574.37
Amiesite, concrete base	5.93	964.37	763.27	201.10
Amiesite, macadam base	5.18	1,557.44	164.74	1,392.70
Open mix, concrete base (including cold patch)	23.59	479.39	284.06	195.33
Open mix, macadam base (including cold patch)	14.27	640.11	292.37	347.74
Bitulithic-concrete base	15.12	1,723.80	504.82	1,218.98
Warrenite bitulithic conc. base	5.62	513.65	44.73	468.90
Willite concrete base	4.87	314.24	173.90	140.34
Bitoslag concrete base	2.31	732.32	413.21	319.11
Sheet asphalt concrete base	0	0	0	0
Gravel mix-gravel base	5.05	1,060.79	601.19	459.60
Henderson-macadam base	0.51	0	0	0
Asphalt block-conc. base	18.97	1,655.62	1,351.87	304.75
Asphalt block macadam base	2.12	969.81	192.92	176.89
Wood block	0.52	89.21	0	89.21
Stone block	3.72	254.97	126.71	128.26
Brick cubes-macadam base	0	0	0	0
Sub-base bituminous	7.10	917.18	796.98	120.20
Bituminous macadam layer method	7.29	842.94	502.33	340.61
Kentucky rock asphalt	14.53	935.44	674.31	261.13
Roomac	0.15	2,232.53	1,505.87	726.66
3 strip dunl (1st cl. conc. and bit. mac.)	72.43	277.29	183.50	93.79
2 strip dunl (1st cl. conc. and W. B. mac.)	0	0	0	0
2 strip dunl brick and W. B. mac.	6.26	1,963.46	1,742.52	220.94
2 strip dunl brick and earth	12.79	252.70	95.73	156.97
2 strip dunal concrete and earth	9.15	243.26	55.14	188.12
2 strip dunl (1st cl. conc. and bit. mac.)	3.85	545.49	296.31	249.18
3 strip dunl concrete and W.B. mac.	4.28	300.75	186.11	114.64
2 strip dunl concrete and gravel	0.70	856.10	710.71	145.39
2 strip dunl brick and bit. mac.	0	0	0	0
2 strip dunl brick and concrete	8.45	1,711.51	1,041.45	670.06
Earth	0.58	0	0	0
Bit. mac. Pen T macadam base	14.65	955.43	782.78	172.65
Bit. mac. Pen. A. macadam base	3.70	780.03	390.41	389.62
Special Telford	0.87	304.09	304.09	0
Average cost per mile	.....	$860	$546	$314

TABLE II—AVERAGE ANNUAL MAINTENANCE COST PER MILE OF PRINCIPAL TYPES OF HIGHWAYS FOR THE PAST TEN YEARS IN NEW YORK STATE

Compiled by David Noonan, New York State Deputy Commissioner of Highways

	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Aver.
Bituminous Macadam, penetration method, asphalt and tar	$483	$408	$557	$501	$590	$753	$613	$974	$845	$1,017	$656
Topeka on concrete base	205	245	435	144	355	229	365	332	545	597	343
Topeka on macadam base	256	393	1,056	443	985	769	730	855	1,370	1,411	827
Waterbound macadam	906	970	739	694	797	951	776	897	914	1,000	864
Brick	176	222	251	247	242	307	303	350	424	564	309
First-class concrete	141	112	160	214	227	225	225	218	333	410	227
Second-class concrete	1,080	1,127	791	761	868	874	691	729	1,079	1,141	914
Gravel	587	918	909	771	704	890	739	814	1,187	1,619	914
Average all types	$651	$643	$608	$560	$631	$744	$607	$712	$757	$860	$677

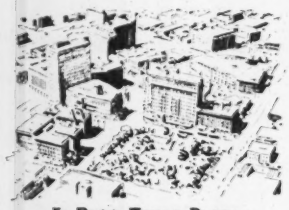
Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits The City Engineer

Snapshots of Our Representative Small Cities

El Paso, Texas



EL PASO, TEXAS, PLAZA

HEALTH CENTER AND COMMERCIAL DISTRIBUTION POINT for western Texas, southern New Mexico and old Mexico, El Paso has developed a large number of manufacturing plants dependent on local raw products. Principal of these establishments are: A smelter handling the coppers of New Mexico, Arizona and Mexico; cement mill; cotton mill, gins, compressors; storage warehouse; flour mills; woodworking plants, getting raw products from as far away as California and Oregon but depending largely on eastern Texas, New Mexico above Albuquerque and old Mexico; structural steel fabricating shops; foundries; brick factories; and cement products. Center of one of the most successful of U. S. Reclamation projects. Outfitting center for mining operations in Mexico. Probably the closest land commercial contact point with Mexico, since the city is at the head of rich irrigated Rio Grande Valley equally supplied on both sides of the border by the Elephant Butte storage reservoir of the U. S. Bureau of Reclamation. It is well served by six railroads up and down the valley, to east, west, north and south. El., 3,700 ft. Area, 11½ sq.mi. Pop., 1920 census, 80,000, now estimated at nearly 100,000.

LOCATED at the extreme western tip of Texas at the pass del Norte in a low mountain range through which the Rio Grande breaks in a wide, flat flood plain continually rising in elevation due to silt deposition, El Paso is at El. 3,700 ft. above sea level and has an equable dry climate of cloudless days and cool nights, invigorating and ideal for health conditions. One of the largest army hospitals and seven large sanitariums are here to care for that phase of the city's growth. For centuries the location has beckoned traffic through the pass along the river and across the border. First settlers occupied the flat area between the river and railroads which skirt the hills but within the last 15 years two-thirds of the populated area has crept up the mesas above the city, the automobile and good paving greatly expediting the movement.

The city therefore is crescent shaped, with its widest three miles perhaps at the downstream horn. The series of mesas are comparatively flat, with 4 per cent grades away from each succeeding escarpment reached by streets with grades not to exceed 5 or 7 per cent. These mesas are made up variously of clay, caliche and rock, while the flat valley with its slope of 2 ft. to the mile is underlain with sand, clay and adobe with water close to the surface. Water supply is available close at hand but not used, dependence being on wells sunk to a sand stratum just under a salt water stratum at 850 ft. depths. Topographically, a high-level and a low-level sanitary sewerage system is suggested, the first for the steep slopes of the mesas and the second for the valley where the low minimum grades require pumping to lift the sewage to the sewage-treatment plant. Eventually an intercepter skirting the base of the mesa will be built for domestic sewage but for the present all of the sewage enters the sewers on the flat area and has to be pumped. Storm water is a problem. Because of the infrequency of rains (10 in. is the rainfall) a close balance must be maintained between the natural man-made channels and dished streets for the purpose of taking care of storm water.

So various are the types of material encountered and so plentiful and low-priced ($1.50 per day) is the labor supply that all trenching is hand work. However, 6- and 8-in. vitrified-tile lines cost about $2 per foot laid, even though pumping and sheeting must be resorted to on the flats and air-drill spades on the mesa. With deposits of this type the builders of skyscrapers which are coming in in the valley usually explore the foundation carefully to get into stable sands. Water is everywhere, one of the hotels continually pumping from the basement into the sewers 150,000 g.p.d. This condition is augmented since the river bed has risen 10 ft. in ten years and now, though above the general level of the city, is kept out by levees. Thereby hangs another tale, for while location of the levees has been worked out scientifically and agreed to by the International Boundary Commission, the governments have not agreed, Mexico insisting first on full adjudication of claims to the banco lands (cutoff loops caused by the meandering of the thread of the river designated as the boundary in past treaties). Some levee work has been done but much remains on both sides which must be carried up simultaneously.

With nearly one-half the streets paved and those paved streets sewered, and water supply development by increased well capacity well cared for, the engineer's principal future problems are lowering the ground water level, provision for storm water, intercepters, levees and a new 2.3-m.g. storage reservoir.

Organization—El Paso has the commission form of government with the four commissioners heads of as many departments: (1) Public works and maintenance, under which is the city engineer; (2) police and fire; (3) parks and roads; (4) public health, sewerage and garbage. To the engineer's office comes all engineering work. The parks need a grandstand and swimming pools. The sewage plant wood-stave outlet rots out in two years and the engineer is asked to build a new one of centrifugally-cast concrete pipe. Design and construction of the water-works structures, pump houses and reservoirs are done by the engineer. Since purchase of the works by the city, a corporation form of control has been continued, with the mayor and aldermen as directors.

Robert P. Anderson is the city engineer, with a staff as follows: One assistant city engineer in charge of paving and surveys; one office engineer and chief draftsman; three field parties of four men each; one chief inspector who helps on design; paving and sidewalk inspectors as required. The average budget is $35,000. For sewers it is $10,000 more but augmented as needed from the general fund.

Paving—Of the 243 miles of streets 113 are paved, mostly with bitulithic or asphalt. In residence districts a 1½-in. top is laid on 6 in. of stone. Downtown, 2 in. is laid on 9 to 11 in. of stone. Over sandy soil, a 1½-in. top is laid on a 4-in. concrete base. A few streets run-

ning over caliche have a 1½-in. top on 3 in. of black base. A few recently paved streets are of concrete.

The combined curb and gutter has a ½-in. batter. The slope on all old parkways is ¼ in. to 1 ft. from property line to curb, but recently because of little or no rain and to keep irrigation water ponded, flatter grades are given.

Pavement patches are repaired by contract, 4 to 5 in. of concrete being laid and left for 60 days to permit settlement. The concrete is then chipped out, stone tamped in and an asphalt top placed.

Streets widths generally are 70 ft. of which 30 ft. is paved in residence districts and 50 ft. down town. Three arterial streets are 100 ft. wide. On these there are two 30-ft. paved ways, one each side of the 9-ft. street car strips. On the Main Valley road, now going in, the single street-car track has been moved from the side to the center and the right-of-way curbed, separating the traffic.

Pavements are paid for by special assessment with the city paying for intersections and alleys from bonds voted by the people.

Permanent monuments are placed 10 ft. north and east of the center of the intersection lines. These consist of manhole-inclosed concrete posts 3 ft. deep, with their tops 8 in. below the pavement surface. The monuments are also used as bench marks but Mr. Anderson prefers locations in small parks away from traffic, particularly in the flat areas. A permanent level survey is now being made.

Sewage—In 1922 the city built 15 sewage settling tanks, each 30x80 ft. and 10 ft. deep, with an outlet weir across the 30-ft. end ahead of which is a 30-in. scum board. The sewage flow averages 5½ m.g.d., with peaks of 11 to 12 m.g.d. Three tanks are used at a time for about three months then the sewage is shut off and the sludge allowed to digest until it stops fermenting, when it is pumped to a sludge field. No analyses are made and little attention paid to the operation. The effluent is dark, cloudy and carries much flocculent material as well as large pieces of black scum or sludge escaping under the scum boards. The concrete work is excellent but if the same material had been put into two-story tanks or some of the later forms of tanks real work might be done. The sewage is well diluted with ground water, the volume of which varies with the river stage, increasing some 15 days after a sudden rise.

Garbage—Garbage is collected every other day down-town and twice a week in residence districts, where it is wrapped. It is hauled to a dump and covered with earth. An ingenious net of ½-in. steel cables with 10-in. meshes held in place by clips is laid on the floor of the 5-ton trucks. At the dump a team is attached by a cable to a 2-in. pipe fastened to the forward end of the net and the garbage is pulled out. If no team is available at the moment, the cable may be attached to a snubbing post and the truck driven forward. The operation takes 12 sec. whereas it formerly required 40 min. to fork out the load. One-ton Ford trucks with home-made high sideboards collect the residence garbage. All of this equipment is housed at a stone-wall-enclosed city corral, described in *Engineering Record*, Jan. 22, 1916, p. 108. A garbage incinerator was built by El Paso more than 10 years ago, but it was never put in operation.

Water—A 2.3-m.g. circular reinforced-concrete reservoir of the Hewitt type, 140 ft. in diameter and 22 ft. deep, with a 4-in. dome roof, just put under contract will bring the storage capacity in the reservoirs to 25.5 m.g.d. The smallest reservoir (tank) is 130,000 gal. and the largest 11½ m.g. Water is pumped by motor-driven centrifugals from six wells averaging 1.6 m.g.d. each. Additional wells on the mesa pumped by air bring the capacity to 16 m.g.d. which may be still further augmented by 2.5 m.g.d. by a surface well for use only in fire emergency. The water is not excessively hard but laundries and some manufacturing concerns soften it. No householders do. The centrifugals require 1 kw.-hr., costing 1½c. per 1,000 gal. to operate.

Street cleaning is done by white wings and mechanical sweepers and is not in charge of the engineer.

City Planning—Zoning has been talked of recently by a city planning commission, but nothing accomplished. In general the residence districts do not appear badly raided by filling stations or garages, and zoning, if it were possible under Texas law, might easily be accomplished.

The city planning commission of five citizens was established by a comprehensive ordinance in 1923. Once a year a written report must be submitted of work accomplished and recommendations. W. E. Stockwell, engineer and secretary, is author of the 1925 report of 70 pages which indicates that the commission has already much to its credit. Certain grade separations, acquisition of land for parks, openings of streets and connections with highways have been made. Engineering matters scheduled for immediate action include wide curb parking on all streets not main traffic ways, a modern lighting system and removal of crooked intersections and projecting corners. The larger pressing problems of an engineering nature under consideration are water supply, 10, 25 and 50 years hence, removal of the railroads from the heart of the city particularly freight traffic, development of connected traffic arteries, connection of the heart of El Paso with that of Juarez, Mexico, by a monumental free bridge with impressive bridgeheads, and development of the river front along with levees.

A trip with Mr. Stockwell around the railroad yards and over the single wooden viaduct entrance crossing the railroads from the rapidly developing upper valley, indicates much work and co-operation ahead for both municipal and railroad engineers. These and other preliminary plans were worked out by the late George E. Kessler but had not been reduced to writing before his death.

El Paso is an excellent example of a city with its engineers well ahead in their thinking out of public demands and financial possibilities. Helpful co-operation apparently exists among the heads of the various official bodies, including American and Mexican engineers of the International Boundary Commission, U. S. Bureau of Reclamation for the tributary valleys, City Plan Commission, county and city engineers. White men settled the region nearly three centuries ago so that El Paso has to overcome many obstacles in the way of precedent that are lacking in new towns. Irregular property lines, defined under strange laws, uncertain water rights of antiquity, age-old customs, all are factors the engineers must constantly bear in mind. Plenty of work and engineering planning remains to be done but the talent is there and actively operating.

Economic Study of Plant Layout For Building Construction

Alternative Plant Plans for Twelve-Story Loft Compared on Basis of Cost and Speed Results Prove Efficiency

By Zara Witkin
Chief Engineer, Herbert M. Baruch Corp., Los Angeles, Calif.

THE quantities in the Harris-Newmark Building in Los Angeles and its location at a heavy traffic intersection made the problem of handling materials, with economy of equipment, both to and on the work, one which warranted careful study. Alternative plans were analyzed on the basis of cost, output and sureness of delivery and the one which is described was chosen. The several factors and results are given; the results were gratifying in the efficiency and economy achieved in producing a large volume of concrete.

Structure and Quantities—The building is a reinforced-concrete store and loft structure, Fig. 1, containing twelve stories and a basement and a mezzanine floor in the first story. The total supported area is 300,000 sq.ft. and the volume of the building is approximately 4,000,000 cu.ft. The shape is a parallelogram with the building lines following obtuse angles made by the intersection of two streets, Fig. 2. This angle was of sufficient magnitude to cause the interior layout of column lines, which are spaced 20 ft. apart, to be skewed with regard to each other, in order to prevent the condition of a triangular, mutilated panel occurring four times on each floor as it would have if rectangular column spacing had been used.

In the construction of the frame of the building there were used approximately 20,000 bbl. of portland cement, 7,000 cu.yd. of sand, equal to approximately 13,000 tons, and 10,000 cu.yd. of gravel, equal to approximately 14,000 tons. These quantities made it necessary to investigate traffic conditions immediately surrounding the site and to plan the material-receiving bins and the truckways to and from them so as to preclude any possibility of serious tie-up, involving delay in delivery of materials and loss of time of the concreting gang when once a large pour was in progress.

Traffic Conditions—The building is located on the corner of Los Angeles and Ninth streets. Los Angeles St. is an industrial artery, being a main truck route for warehouses, light manufacturing and wholesale bulk-goods-handling concerns located on and about the street. Ninth St. is a crosstown artery from the industrial section of the city, through the wholesale district, the financial, the shopping, the apartment and finally the residential districts, and bearing a considerable street railway traffic. West of the building is a paved alley emptying into Ninth St.

Midway between Los Angeles St. and the alley-way, one 20-ft. panel-width removed from the Ninth St. building line, were two passenger elevator shafts in one of which it was desired to place the hoist-tower for elevating mixed concrete.

Plant Plan Analysis—The problem of plant lay-out resolved into two parts: First, how to enter the building with trucks to deposit cement and aggregates and then to leave without causing traffic disturbance and clogging operations on the job; second, how to handle the aggregates from point of dumping from trucks into the concrete mixer, with minimum labor cost and maximum simplicity, efficiency and certitude. In solving the first part of the problem, two alternative schemes were studied as shown by Fig. 2.

It was first proposed that trucks come west along Ninth St., stop in front of the middle of the building, turn out into the street, back into the building, up a short ramp and unload sand in a bin situated opposite columns 38 and 39 and dump gravel into a bin opposite

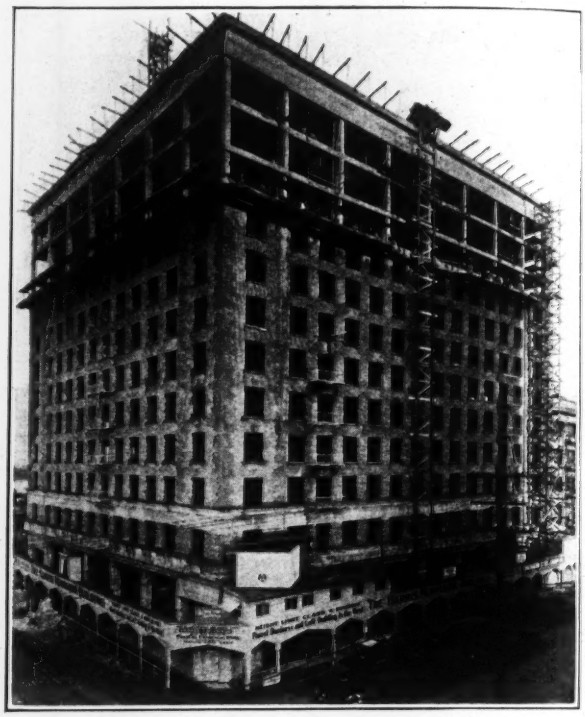


FIG. 1—TWELVE-STORY HARRIS-NEWMARK BUILDING, LOS ANGELES

columns 39 and 40. The advantage of this method was a short ramp of low cost. There were, however, some important disadvantages:

1. Trucks turning into the street might block traffic and incur the ill will of police authorities.

2. Backing in of trucks is a slow proceeding and within such narrow clearances as were available meant practically blind and dangerous driving.

3. A truck in backed-in position would prevent others from entering.

4. The bin location would necessitate special cutting of the flat slab and construction of beams around openings later to be filled over.

5. The short ramp would necessitate dumping trucks on an incline involving some difficulty in unloading and some danger of slipping down the ramp.

The alternative method was to enter the building on a long ramp beginning at Los Angeles St., run directly through the front panel of the building facing Ninth St., dump sand and gravel and cement and proceed in the same direction to the alley and out on Ninth St. without blocking other trucks from the ramp or the street car and other traffic of Ninth St. This second scheme required a ramp 160 ft. long. Tentative designs and estimates of construction cost of the two ramps indicated that the difference would amount to approxi-

mately 10,000 ft. b.m. of heavy timber framing amounting to about $600, which was only 4c. per cubic yard of the total volume of concrete. It was decided that the advantages obtainable by the second method in contrast

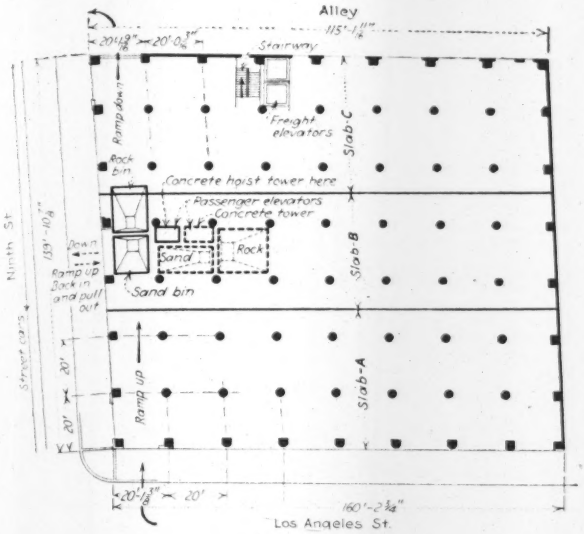


FIG. 2—ADOPTED AND ALTERNATIVE CONSTRUCTION PLANT LAYOUT

In construction plant, solid lines show layout adopted, dotted lines show the alternative plan. Each slab as shown, *A*, *B*, and *C*, was concreted in a single pour.

to the first outweighed this additional cost and it was accordingly adopted.

Truckway and Bins—The truck ramp was then designed and the bents placed wherever possible to bear upon concrete footings in place, saving individual post footings and extra post and bracing lengths. The ramp truckway general plan is shown by Fig. 2. The design is shown by Fig. 3. The design was based upon three primary factors: (1) The gross weight of a loaded truck which equaled 34,000 lb. or 17 tons, a six-wheel-dump-body-aggregate-handling truck; (2) the gage and treadwidths of this model machine, for which treadways and guard rails were provided; (3) the maximum rise above first floor level, which was the entrance level of the ramp, to secure maximum depth of bins and to be compatible with satisfactory overhead clearance for a dump-body in a completely elevated position under the second floor slab. These factors were, of course, established by actual measurement of trucks to be used.

The bins were lined with galvanized iron sheets to cause easy flow of material into the hoppers and also to drain as much water as possible from the aggregates. In actual operation with bunkers full, there was a steady stream of water out of the bottom of the bins.

Handling Materials to Mixers—When the problem of handling the aggregates from the bins to the mixer presented itself, several different means of achieving the result were studied, involving the use of different combinations of skilled and unskilled labor, equipment, motors and power.

It was essential to provide in the bins sufficient storage to obviate the contingency of a halt in concreting, when a pour was in progress, owing to a delay in delivery of aggregates. Since the average pour was approximately 300 cu.yd. in a run of eight hours (using a ¾-cu.yd. mixer), it was decided that three hours' supply of aggregates was necessary, *i.e.*, sufficient for about 112 cu.yd. or about 56 cu.yd. of sand and 82 cu.yd. of gravel. The actual capacities of the bins as finally designed were: sand 58 cu.yd. and rock 75 cu.yd.

To obtain these bin capacities, maximum possible bin depth was sought, this being a variable controlled by a 15-ft. basement height and a 21-ft. first floor height. Since it was decided to use batch hoppers under the bins (and later an inundator) the height available for bin depth was reduced 4½ to 6 ft. The mixer measured 7½ ft. over-all height from platform to top of loading hopper. The mixer was sunk in a pit below the basement floor to a level permitted by the footing for the elevator shaft in which the concrete hoisting tower was placed.

The several proposed methods of handling the aggregates from the bins to the mixer were: (1) By handcarts wheeled from bins to mixer; (2) by conveyor car and hoist; (3) by two conveyor belts carrying sand and gravel from each of two bins, separated, to the mixer; (4) by single conveyor belt carrying sand and gravel together from two adjacent bins to mixer; and (5) gravity discharge from bins through batch hoppers.

Fig. 4 tabulates these methods, showing a schematic arrangement of a section through the building in the panel containing the truckway bins and mixer, and lists the men, skilled and unskilled, equipment and power necessary in each case.

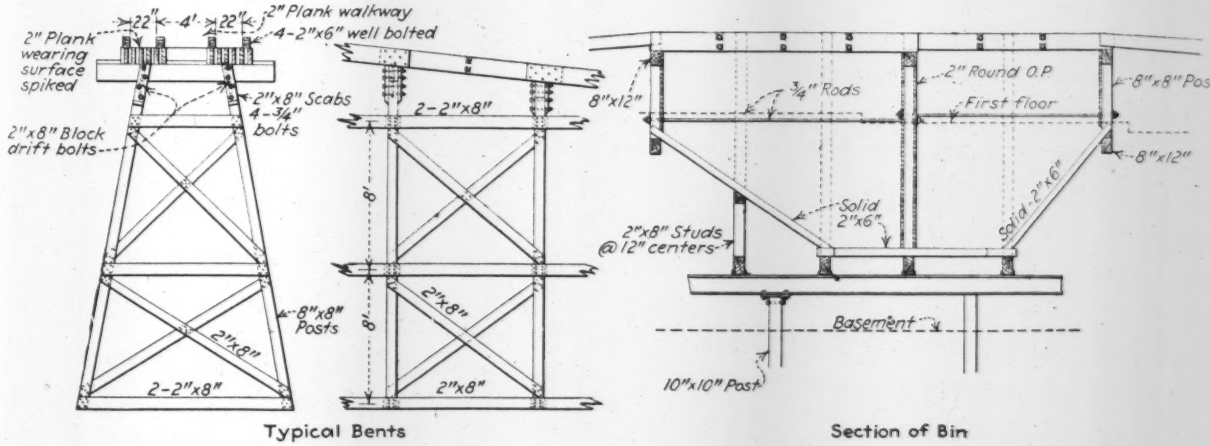
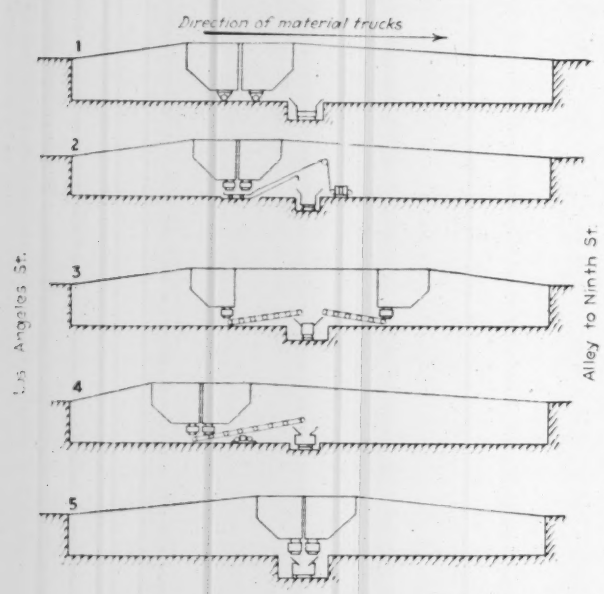


FIG. 3—RAMP TRESTLE AND HOPPER DESIGN USED IN CONSTRUCTING HARRIS-NEWMARK BUILDING



	Laborers	Hoistmen and Hopper Tenders	Machines	Power
1. Bins together, laborers and carts wheeling loads to mixer	12–14	None	None	None
In general applicable to all except A. Use split cone in mixer hopper and eliminate measuring hoppers on bins	....	....	.....	.....
2. Bins together, charging car collecting from measuring hoppers, hoisted and dumped into mixer	None	2	Charging car track hoist	Hoist engine
3. Bins separated, 2 belt conveyors operated by same hoist but using 2 clutches collecting from measuring hoppers and dumping into mixer	None	2	Two belt conveyors	Conveyor engine
3a. Belts working directly against openings in bins, no measuring hoppers used	.....	....	.....	
4. Bins together, single belt conveyor collecting from measuring hoppers and dumping into mixer	None	2	One belt conveyor	Conveyor engine
4a. Conveyor working against bin openings, no hoppers used	....	....	.....	.....
5. Bins together, mixer sunk in pit, volume-measuring rock hopper and sand-inundator hopper dumping directly into mixer. (This was the method adopted)	None	1	None	None

FIG. 4—ALTERNATIVE METHODS CONSIDERED FOR HANDLING AGGREGATE TO MIXER

When so listed and studied the soundness of the selection of the adopted method five is apparent. But before it was established that the decreased bin capacity arranged for gravity discharge through hoppers into the mixer was sufficient to meet expected contingencies, the other methods considered were carefully weighed and the special advantages of each were brought out. The ordinary method of using hand labor and wheeling carts, of course, eliminated all machinery, even batch hoppers, but added a fairly heavy labor charge to the concrete plant. Of the mechanical methods, three probably would have been most simple, effective, positive and due to low car height would have allowed greater bin capacity. On the other hand it required a separate

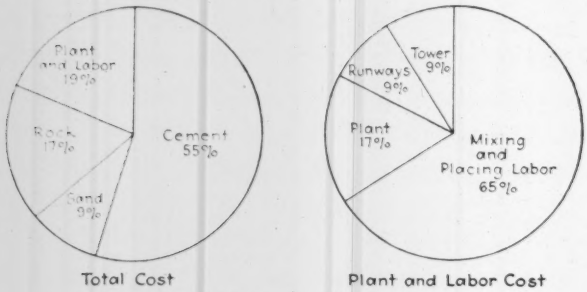


FIG. 5—COST ANALYSIS GRAPHS

hoist and hoistman and a special car and track and batch hoppers under the bins, with a man to control them. It was found that even deducting the required heights for the hoppers between the mixer and the bins, sufficient depth was not available for minimum bin storage requirements.

Accordingly the simplicity and the absence of men and motor and hoist or belt equipment in a dark, restricted working space, which a gravity discharge method offered determined its selection. Later on, with the installation of an inundator under the sand bin, the plant was in its final form and the entire labor force consisted of one man at the chute delivering cement to the mixer, one man controlling the inundator and the rock hopper, and one man on the mixer itself.

Output and Cost—The average single pour, shown by Fig. 2, covers about one-third of a typical floor area and equals upwards of 300 cu.yd. of concrete. In placing this concrete, the consideration of the use of chutes or runways arose and it was solved by a combination of the two methods owing to the central position of the tower at one side of the building. A 40-ft. section of chute was used which served the end of the building where the tower was situated. Runways and concrete cart deposition were used in conjunction for the remainder of the area, collecting from a floor-hopper into which the chute emptied, affording flexibility and avoiding having the men with the carts wait for each cart-batch.

A graphical analysis of costs of handling concrete aggregates, mixing concrete and placing concrete is given by Fig. 5, illustrating the results obtained by the studies made and the methods used as outlined above.

Analysis of the cost diagrams of an average cubic yard of concrete in place, both total cost, and plant and labor cost, will emphasize the economy and efficiency of the methods adopted; plant cost was only 17 per cent of the net labor and plant cost of handling a cubic yard of concrete from the stage of loose aggregates to that of mixed concrete, in place, and only 3 per cent of the total cost of the concrete, including materials.

The final test of any such plant arrangement is the manner in which it meets the requirements for which it was designed. In this case there were no instances of holding up a pour of concrete for non-delivery of materials, the bin storage meeting the needs at all times. The operation of handling the aggregates from the bins to the mixer was performed with an insignificant amount of labor and no break-downs in service.

The building was designed by Courlett & Beelman, architects, and Oliver Bowen, engineer. The contractor was the Herbert M. Baruch Corp., Los Angeles, Calif.

Handling a Large Water Flow in the Moffat Tunnel

Muck Pile Moved Back from Face 200 Ft.—Rescue of Mucking Machine in Waist-Deep Water—Pipe Laid on Trucks

By C. A. Betts
Office Engineer, Moffat Tunnel Commission, Denver, Colo.

On the night of Feb. 28 a large water course, delivering approximately 3,000 gal. per minute, was cut in the main heading of the Moffat railroad tunnel at East Portal. The round had been shot and the mucking crew went in to clean up. While the mucking machine was clearing the fly rock and working toward the heading the shifter placed a cluster of lights in the heading and returned for tools to crosscut 10, about 300 ft. back. Upon returning to the heading where the pressure of the inflow from the floor had started to shift the muck pile, the foreman received the impression that his lights had been moved. The water then broke through lifting the 40 cu.yd. of rock back about 20 ft. so that some of it was carried against the approaching mucking machine and hampered the work of rescuing it and moving it up the 0.8 per cent grade past the crosscut to the apex, 1,300 ft. east. By the time the crew reached crosscut 10 the water was waist-deep, but as it flowed through the crosscut and into the water-tunnel heading, which is parallel with and 75 ft. to the south of the main heading (and 32 ft. ahead of it at the time), there was an opportunity, before this working was flooded at 3 a.m., to remove most of the machinery, build a bulkhead of sand bags across the main heading east of crosscut 10 and set up pumps to direct the flow east through the water tunnel to crosscut 8, and thence cut through the 16x24-ft. railroad bore, thus leaving the enlargement operations west of the crosscut undisturbed.

For two days the flow of about 3,000 gal. per minute ran 4 in. deep over the railroad tunnel tracks, after which the water subsided to 1,500 gal. a minute by March 7, at which stage it remained for about thirty days. By April 10 the flow in the main heading was down to 1,000 gal. per minute and drill holes in the water tunnel, which was being driven ahead, struck water. From then on the flow in the water tunnel increased until on May 1 it was 650 gal. per minute, while that in the main heading had decreased to the nominal amount of 150 gal. per minute, as the water-bearing seams were tapped by the water tunnel.

WATER CARRIED GRAVEL 200 FT. FROM FACE OF TUNNEL

Low-head motor-driven centrifugal pumps mounted on flat cars were used to unwater the headings. About 1,200 ft. of discharge pipe was mounted on strings of trucks extending to the apex and added to as the water receded. Subsequently the pipe lines were placed along the side of the tunnel and permanent installations with sumps made. It was found that gravel and rock that washed in from the seam had filled the main heading for about 200 ft. This material had to be removed while saturated with water, and while the inflow which continued knee-deep washed in new sand.

PIPE ON TRUCKS FOR WATER PUMPED OVER TUNNEL APEX

At the time of the inflow the headings were more than 2,700 ft. beneath the surface of the Continental Divide where the barren rock gave no indications, other than a dike running along the backbone of the Rockies, that the water-bearing seams existed. For thirty days preceding the flood wet seams carrying as high as 500 gal. per minute had been encountered.

Throughout 250 ft. driven since March 1 in the water tunnel the roof and side walls have dripped large quantities of water but no main seam has been cut.

New Jersey Water Supply Situation Reviewed

At the meeting of the American Water Works Association in Buffalo, H. T. Critchlow, engineer, Board of Conservation, Trenton, N. J., stated that after reviewing the state water supply control and the Hazen and Sherrerd plans to meet the needs of the northeastern parts of the state by a successive tapping of streams until the Delaware is reached, with immense storage reservoirs at Long Hill and Chimney Rock, and the bills for a state water policy and plan to be introduced in a special session of the legislature June 22, he questioned whether the two state water districts should be authorized to select their sources of water supply and authorize and contract works, or whether the state should continue to control all the sources. He favored the latter, if both districts go to the Delaware River.

Multifarious Problems of the Water-Works Man

Abstracts of Papers at Buffalo Convention of American Water Works Association, Grouped Under Intakes, Pumping Stations, Purification, Distribution, Design and Operating Problems

Water-Works Intakes

Lake Current Studies and a General Study of Intakes on the Great Lakes

Lake Current Studies: D. E. Davis, Erie, Pa.—A study of lake currents as affecting the water supply of Erie, Pa., showed a notable deviation from conclusions as to the relation between winds and float movements. This was attributed, after obtaining data from Weather Bureau stations to the East and West, to the lowering of waters at one end and their piling up at the other end of the lake.

Intakes on the Great Lakes: George H. Fenkell, manager, Detroit water-works—Many problems associated with the design of lake intakes together with a mass of data on the location and design of intakes on the Great Lakes, ice troubles and other pertinent matters were summarized in a 30-p. paper.

* * *

Pumping Plants

Diesel-Engine-Driven Pumps, Station Logs and Use of Pulverized Fuel

Diesel-Engine-Driven Pumps: Rodney D. Hall, engineer, water-works department, Worthington Pump & Machinery Corporation, New York City—The present standard sizes of Diesel engines, as built by the Worthington company, start at 30-hp. single-cylinder units. Sizes up to 9,000-hp. six cylinder units are proposed. In steam-driven pumping machinery the steam economy increases considerably with the size of the unit, while Diesel-engine units in the small sizes are within about 10 per cent of the economy of the largest units. The fuel consumption in our entire line of Diesel engines is less than 0.5 lb. of oil per brake hp.-hr., containing 18,500 b.t.u. per lb., giving a "duty" of about 215,000,000 ft.-lb. per 1,000,000 b.t.u. With a centrifugal pump driven through speed-increasing gears having a combined efficiency of 80 per cent this gives an over-all duty of 172,000,000 ft.-lb. per 1,000,000 b.t.u. consumed, which is increased to 190,000,000 when the Diesel engine is direct-connected to a reciprocating power pump of 88 per cent efficiency. It should be remembered that the oil engine is complete in itself and does not require boiler house, boilers, stock and handling machinery and other steam auxiliaries.

Essential Pumping Log Data: Isaac S. Walker, president and general manager, New Chester Water Co., etc., Philadelphia, Pa.—The daily log of the chief engineer of a water-works pumping plant should include at least the following: Names of the engineer and fireman on each watch; fixed-interval pump counter readings of each pump; counter readings at time of starting and stopping; total revolutions; total hours pumps are operated; total pumpage; pounds of coal used; kind of coal used; average b.t.u. per pound of coal; hours of service for each boiler; total ashes; per cent ash; average steam pressure; average water pressure; average vacuum; suction and discharge heads in feet; total head in feet; average temperature of the weather, the boiler room, the feed water and the water delivered.

If means permit, it will also be desirable for the plant operator to equip his station with some or all of the various devices for the detection of waste, and improvement of efficiency, among which are: A meter or meters showing the total plant output, or preferably the output from each pump; a boiler-feed-water meter; draft gages for each boiler; a CO_2 recorder; steam-flow meters, or a measuring device for the condensate from each pump condenser; a recording tachometer to provide a record of the pump speed; recording thermometers to provide a continuous record of the temperatures of the weather, the boiler room, the boiler feed water and the flue gases.

Pulverized Fuel at Des Moines: Charles S. Denman, general manager, water plant, Des Moines, Ia.—An 8-hr. test of the use of pulverized fuel at the Des Moines pumping station was made May 13. [See *Engineering News-Record*, Jan. 21, 1926, p. 107, for description of pulverized fuel equipment.] The coal was weighed and measurements of the water were taken with a V-notch meter. The test showed an average boiler efficiency of 81.05 per cent with 6.18 lb. of water evaporated per pound of coal consumed as fired. The undried coal was fed from the bunker to the pulverizer.

Pulverized fuel effects an economy during banked boiler hours due to the fact that by stopping the fuel and closing the dampers and auxiliary air inlets the boiler is made similar to a thermos bottle and steam pressure can be held for several hours. The furnace brickwork having been heated to incandescence during the operation gives off a radiant heat which is almost all absorbed by the boiler rather than escaping up the stack. The boiler has many times actually stood for a period of from 12 to 14 hours and then been put back on the line in from 5 to 8 minutes. Also when it has been off the line for a long period and become absolutely cold it has been put back into service in 20 minutes.

We are now installing a second pulverized fuel unit and as soon as expert tests are made verifying our expectations it is our intention to remove the present stokers and convert the plant entirely to the use of pulverized fuel. This second unit is driven by a steam turbine and the exhaust steam from this turbine is to be used in drying the coal.

* * *

Water Purification

Algæ Treatment, More Filters at Washington, Changes in Detroit Filters, Federal Studies

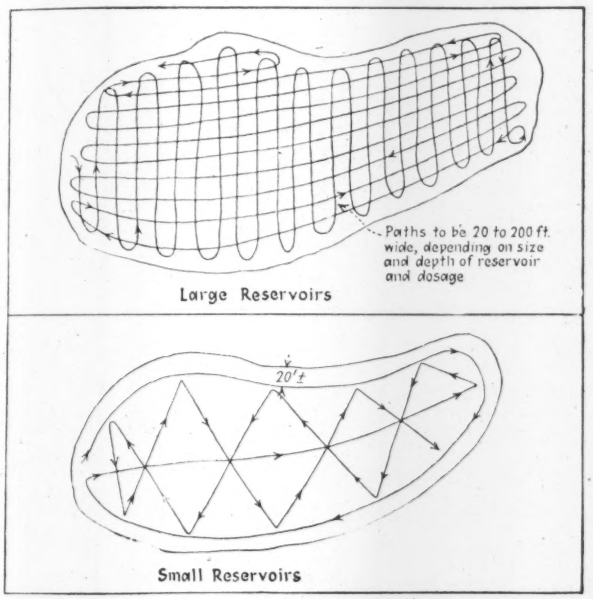
Algæ Treatment: Frank E. Hale, director of water laboratories, New York City—On Aug. 25, 1925, Jerome Park reservoir, New York City, was treated with copper sulphate for asterionella, 1,500 units, dosage 0.18 p.p.m. Contrary to usual practice the reservoir was not turned into service again until Sept. 8, two weeks later. Within a few hours some 300 complaints were received over the telephone of foul-tasting water. The reservoir was immediately shut off again. Samples examined from top, middle and bottom depths indicated that the decaying organisms had concentrated in the bottom water, and as draft was from the bottom the full effect of the treatment was experienced. Usually taste and odor from treatment disappear in two or three days and experience like the above has not been noted. The complaints were well justified judging from certain of the samples received. Meantime a secondary growth of dinobryon occurred, 1,550 units, the protozoa probably feeding on the decaying asterionella or on the bacteria which rapidly increase following the killing of microscopic organisms, since the dinobryon predominated at the bottom. A second treatment was given on Sept. 14 of the same dosage and it is interesting to note that although, as usual, the surface water was treated, the organisms which were at the bottom were entirely destroyed. The depth of the reservoir is about 25 ft. Great care was exercised in turning the water on again. Samples from top, middle and bottom were again examined and the reservoir turned into service gradually from mid-depth, beginning on the 19th. By the 24th it was about one-half in service, all that could be taken from mid-depth. Bottom draft was then commenced and increased until the reservoir was entirely in service. Observations of taste were made frequently at the reservoir as it was turned gradually into service, both of the effluent and of the bypassed water. As a result of this experience, a new procedure for treatment and putting into service of reservoirs was outlined and distributed. The main points of this procedure are:

Care in distributing the copper sulphate rapidly and uniformly. The accompanying diagram shows the course of the boats for large and for small reservoirs. On large reservoirs the courses are parallel in one direction and then

parallel in a direction at right angles to the first. On small reservoirs the courses triangulate the surface.

Prompt inspection, if possible the third day after treatment, noting local conditions such as odor arising from the surface of the water, particularly to leeward of any wind, and physical appearance of the water. Laboratory examination of samples should note whether organisms are dead, in process of decomposition, or mere shells, particulrly noting the appearance of coloring matter, whether faded or jumbled in appearance, also the promptness with which organisms settle in the bottles on standing.

Prompt turning of the reservoir into service on notification. Wherever possible, when turning a reservoir into service again, the flow should be established gradually, mixing effluent water with bypassed water and noting turbidity, taste and odor of both effluent and mixed flow. If required, this process may take several days. Every effort should be made to prevent stirring up deposits either in reservoirs or in conduits which have been idle or full of stagnant water. If possible, avoid drawing water from the extreme bottom of a reservoir following treatment. Mid-depth or at least ten feet above the bottom is preferable.



METHODS FOR COPPER SULPHATE TREATMENT OF RESERVOIRS

Surface draft may sometimes be advisable, but should not be continued, to avoid stagnation effects in the reservoir.

More Filters at Washington: Philip O. Maqueen, U. S. assistant engineer—The 80-m.g.d. slow sand filters built at Washington, D. C., twenty years ago are being supplemented by rapid filters of the same nominal capacity. The alum mixing chambers have around-the-end baffles to meet local hydraulic requirements. The alum solution can be applied before and after the water passes through the mixing chambers, and also between the settling basins and the filters. The filters are in 4-m.g.d. units, with controllers, piping, and equipment designed for flows of 1 to 6 m.g.d. per unit. The strainer system will be of the new open wood-slat type similar to that now being installed in the additional filters at Baltimore. Syrup of alum, made at the plant by the Hoover process, will be used as a coagulant. As the filter plant is located in a residential section, near a future parkway, unusual attention was given to the architectural features of the buildings and finally the American Colonial type was chosen and the plans have been approved by the Fine Arts Commission of the National Capital.

Iodide-Goiter Water Treatment: A. F. Mellen, filtration engineer, Minneapolis, Minn.—No definite action has been taken to apply iodide to the Minneapolis water supply to control endemic goiter, as has been advocated by the health and water departments and the local medical association (see *Engineering News-Record,* Aug. 27, 1926, p. 352).

New Automatic Chlorinator: W. J. Orchard, Wallace & Tiernan Co., Newark, N. J.—The vacuum type of chlorinator which automatically proportions the flow of chlorine to the flow of water was described. (See *Engineering News-Record,* May 27, 1926, p. 879.)

North Carolina's Achievement: H. E. Miller, engineer, State Board of Health, Raleigh, N C.—In obtaining improved technical supervision of the many water treatment plants in North Carolina, most of which serve places of but a few thousand population, two general plans were followed: the first being the training of the "practical" operators found in charge of the plants and the second being to induce municipalities to employ technical school graduates, who also require more or less training after assuming charge. In both cases experienced engineers and operators of the state department of health visit the plants at intervals, staying a week or more to break in new men. The smaller municipalities are induced to provide simple laboratory apparatus, which the operators are shown how to use. In some places the plant operators make milk tests as well as water tests. By means of the general plan outlined several score water treatment plants in North Carolina formerly under little or no proper control are now well operated, with greatly improved sanitary and economic results.

Changes in Detroit Filters: William M. Wallace, superintendent—An operating capacity of 320 to 360 m.g.d. makes the Detroit rapid sand filters the largest filtration plant in the world. Some operating experiences for 18 months are here summarized. The main feature of design differing from other plants of this type is its small mixing chamber in relation to the capacity of the plant. The chamber is 18 ft. wide by 240 ft. long. To give thorough mixing at high velocities the chamber has a diversified system of alternate sets of vertical and horizontal baffle walls so arranged that at maximum operating capacity the velocity through the chamber is about 90 ft. per min. and the mixing period slightly under 3 min. After six months of introducing the alum at the initial point of the chamber it was decided to move the point of application back into the raw water flume so as to give 100 ft. of travel under the mixing effect of the discharge of the low-lift pumps. The longer mixing period has been found advantageous, not materially in flocculation but rather in giving longer filter service.

Another lesson from experience has resulted in a decision to increase the filtered water storage, which from the standpoint of operation is only 15 m.g., or less than enough for 2-hr. service. This necessitated operating the filters at high rates to meet peak loads, throwing filters in or out in order to meet changes in demand. Thus on June 25, 1925, 75 of the 80 filter units were operated to meet a total mean demand of 312 m.g.d. and at midnight only 45 filters to meet a demand of 187 m.g.d., the rate per acre being constant at 166 m.g.d. and the total volume filtered for the day being 264.6 m.g. The additional filtered water reservoir will enable the plant to be run at from 125 to 140 m.g.d. per acre or 3 to 3.5 m.g.d. per filter unit. This will give a longer period of coagulation and sedimentation, longer filter runs, and higher bacterial efficiency.

Disposal of mud balls formed in 80 large filter units caused some concern. Screening seemed to be impracticable. Pending means to prevent mud ball formation good results in removal have been obtained by treating the sand in 1/16th portions of the beds by means of apparatus placed on a portable platform over the wash-water troughs, the device consisting of two 10-in. propellors (one right and one left), with 15-in. pitch, set 12 in. apart on the lower end of a vertical shaft driven by two 350-r.p.m. electric drills. Before the propellers are set in motion the wash water valve is partly opened and the sand put into suspension.

Progress in Ohio: F. H. Waring, chief engineer, Ohio Department of Health, Columbus—Pre-chlorination researches are in progress at Akron in an attempt to eliminate a troublesome gas-forming organism that survives the usual filtration and chlorination. At Ironton and Sandusky researches are being made on the use of chlorine to relieve extremely high bacterial loads upon ordinary purification processes. Other researches are on the adjustment of pH value for optimum coagulation; on double coagulation; on excess lime treatment, which has been proved a success; on a combination of the three last-named.

In softening, lime-soda is being used at some and zeolite at other small municipal plants. At other places iron removal and softening are being combined. There is a gen-

eral trend toward softening in all new municipal water treatment plants in the state.

In equipment there may be noted the general use, in new installations, of dry-feed chemical apparatus; mechanical chemical mixers; Dorr thickeners for settling tanks at softening plants; and devices or methods for utilizing carbon dioxide in water softening.

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An analysis of these figures will show that the metered consumers in that year were paying 62 per cent of the total revenues for 30 per cent of the water pumped, while the unmetered consumers paid 38 per cent for 70 per cent of pumpage. Deducting the amount of free water, estimated at 17,640,000,000 gal., the metered consumer paid at an average rate of 6.15c. and the unmetered consumer at a rate of 1.87c. per 1,000 gal. of water received. On considering that the metered consumers were those using large quantities of water, this unfair distribution of charges becomes even more marked.

The accompanying table shows what 13 cities other than Chicago have done in the way of universal or extensive metering and its effects on consumption, both by cities and for the entire group. The gradual upward trend in per capita consumption [in some of the cities] is no argument against meters. It is generally due to one or more of the following causes: Higher standard of living; increased water pressure; reduced rates through more economical operation; increasing industrial activities.

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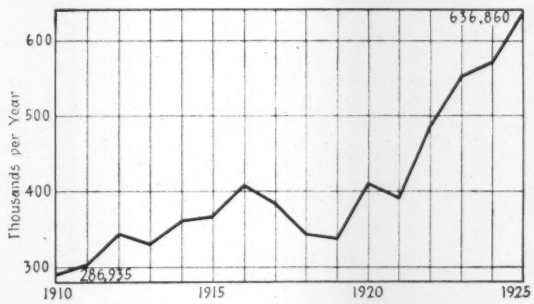
City	Universal Metering Adopted Date	—Per Cent of Services Metered— 5 Years Previous	Time of Adoption	5 Years After	1925	——Per Capita Consumption—— 5 Years Previous	Time of Adoption	5 Years After	1925	Population Time of Adoption	Estimated Population July 1, 1925	Per Cent Increase	Rate per 1,000 Gals., Cents
Detroit	1913	10.0	23.6	97.4	99.07	162.0	163.0	144.0	130.0	624,139	1,257,634	101.0	8.7
Cleveland	1901	4.9	68.0	100.0	100.0	168.9	130.7	96.1	127.4	399,658	912,502	128.0	8.0
Los Angeles	1905	0.0	19.1	55.4	99.0	300.0	175.0	141.0	119.0	210,838	705,411	234.0	9.7
Milwaukee	1899	61.0	83.0	95.0	99.0	101.0	83.0	86.0	128.0	277,231	492,087	77.0	9.3
Newark	1915	49.0	60.6	92.2	95.3	107.0	110.0	108.2	100.2	380,996	445,606	14.0	19.2
Minneapolis	1905	25.1	45.7	79.6	100.0	92.7	66.5	73.8	107.8	252,063	417,280	65.0	8.0
Cincinnati	1915	32.8	64.9	98.2	98.6	127.8	125.9	123.4	161.1	382,419	407,835	6.0	16.0
Kansas City, Mo.	1905	29.0	38.0	44.4	82.5	60.7	93.8	98.0	125.7	206,066	359,650	74.0	22.7
Rochester	1905	28.6	41.0	97.0	99.0	76.2	78.9	80.8	93.9	190,378	325,211	71.0	16.0
Columbus	1905	32.0	76.2	91.31	99.1	150.0	59.6	75.6	92.8	153,530	266,709	74.0	16.0
Oakland	1910	43.6	57.2	100.0	100.0	90.9	85.6	54.3	64.1	150,174	246,893	64.0	27.9
St. Paul	1912	51.1	84.8	97.3	99.5	60.7	60.9	81.2	71.5	218,734	243,946	12.0	12.0
Akron	1912	25.0	45.0	100.0	100.0	106.3	117.2	93.2	87.0	96,941	278,119	187.0	21.4
Average or total 13 cities	Since 1901	30.1	54.39	87.5	97.8	123.4	103.8	96.5	104.8	3,543,167	6,358,883	79.0	15.0



METER OUTPUT OF FIVE MANUFACTURERS, 1910-1925

Chicago's meter problem due to the War Department order in the Drainage Canal diversion case that all services must be metered in ten years will be appreciated in part by the mere statement that, allowing for 6,000 new services each year some 40,000 meters must be set annually.

Hydrant-Flow Surveys: George H. Fenkell, general manager, water-works, Detroit, Mich.—In 1919-20 we made a hydrant-flow survey of the entire city of Detroit. It was followed by a plan for reinforcing all districts having a deficiency of supply. Much of this was accomplished by laying 8-, 10- and 12-in. mains, at a total expenditure of $2,000,000 in 1921 and after all betterments had been made as a result of this survey, a re-survey was undertaken that covered all of the areas found originally to have a deficient supply, and in no case did it appear that the additions to the system did not correct the deficiencies that had been noted.

The survey was made by three men from the water department and two from the fire department. The equipment included a number of pressure gages which could be read to pounds and which were mounted on hydrant nozzle caps, and several hydrant-flow pitot tubes which were connected to pressure gages which also read to pounds. The orifice of the pitot tube that was used was slightly less than ¾ in. in diameter and was mounted on the sharp edge of a knife blade brass casting about 4 in. long. This was connected to a brass tube about 12 in. long, and this in turn was connected to the pressure gage. This type of orifice and gage closely conforms to that used many years ago by John R. Freeman and is the type now in use by the National Board of Fire Underwriters. The coefficient of this pitot tube gage has been found to vary from 0.85 to 0.96, with an accepted average of 0.90.

The hydrants were divided into groups usually of four, and about 1,500 of these groups were investigated. The engineer in charge of the party was provided with a copy of a map of the distribution system and the groups that were to be investigated were laid out on this map in the field. The desirable and usual layout of a group provided a central hydrant from which the remaining three hydrants were visible. The engineer remained at the central hydrant and sent one of his assistants to each of the other hydrants in the group. The pressure gage was attached to the central hydrant and the water was turned on to this gage. The pressure indicated was recorded every 15 seconds for a period of one minute or until a representative pressure had been recorded. The engineer then signaled one of his assistants to open wide the hydrant at which that assistant was stationed and from which the hydrant cap had been removed, but the engineer would continue to record the pressure each 15 seconds noting on his record that the first hydrant had been opened. The assistant had previously measured and recorded on a form with which he had been provided the diameter of the hydrant nozzle. After the air had been expelled from the hydrant and the nozzle filled with water, the assistant placed the orifice in the center of the stream and recorded the pressure indicated on the gage mounted on the orifice pipe. The engineer, still recording pressures every 15 seconds, would then signal for the second hydrant to be opened. Then his assistant at the first hydrant would take a reading of the orifice gage when the second hydrant was opened. This procedure would continue until all hydrants in the group had been opened. If there were three opened hydrants in the group, the first assistant would have three flow readings to record. The second assistant would have two flow readings, and the third assistant would have one reading. When the hydrant had been closed finally, the engineer would record the pressure at the central hydrant. All gages were numbered and a record made on the sheets of the gage used for the recorded set of readings. The pressure gages were tested frequently and corrections were made on the last observed pressure for any error of registration.

The field records were turned into the office at the close of each day's work. The gallons discharged per minute from each hydrant was then computed from the observed pressures, and this information, together with the pressures obtained at the central hydrants, was posted on a large map. The formula that was used for converting the pressures as indicated by the gages into gallons discharged per minute is as follows: $26.8\ D^2\ \sqrt{P}$ = gal. per min. Here P is the recorded pressure in pounds as shown by the pitot tube gage, and D is the diameter in inches of the hydrant discharge nozzle. This takes into account the instrument coefficient 0.90 before mentioned.

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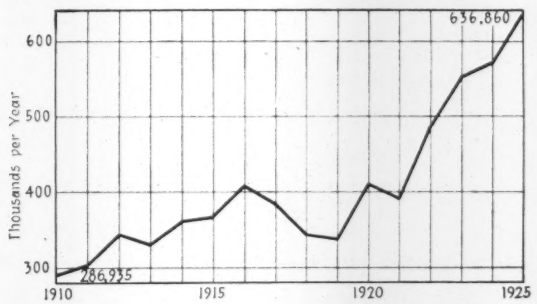
Los Angeles	1905	0.0	19.1	55.4	99.0	300.0	175.0	141.0	119.0	210,838	705,411	234.0	9.7
Milwaukee	1899	61.0	83.0	95.0	99.0	101.0	83.0	86.0	128.0	277,231	492,087	77.0	9.3
Newark	1915	49.0	60.6	92.2	95.3	107.0	110.0	108.2	100.2	380,996	445,606	14.0	19.2
Minneapolis	1905	25.1	45.7	79.6	100.0	92.7	66.5	73.8	107.8	252,063	417,280	65.0	8.0
Cincinnati	1915	32.8	64.9	98.2	98.6	127.8	125.9	123.4	161.1	382,419	407,835	6.0	16.0
Kansas City, Mo.	1905	29.0	38.0	44.4	82.5	60.7	93.8	98.0	125.7	206,066	359,650	74.0	22.7
Rochester	1905	28.6	41.0	97.0	99.0	76.2	78.9	80.8	93.9	190,378	325,211	71.0	16.0
Columbus	1905	32.0	76.2	91.31	99.1	150.0	59.6	75.6	92.8	153,530	266,709	74.0	16.0
Oakland	1910	43.6	57.2	100.0	100.0	90.9	85.6	54.3	64.1	150,174	246,893	64.0	27.9
St. Paul	1912	51.1	84.8	97.3	99.5	60.7	60.9	81.2	71.5	218,734	243,946	12.0	12.0
Akron	1912	25.0	45.0	100.0	100.0	106.3	117.2	93.2	87.0	96,941	278,119	187.0	21.4
Average or total 13 cities	Since 1901	30.1	54.39	87.5	97.8	123.4	103.8	96.5	104.8	3,543,167	6,358,883	79.0	15.0



METER OUTPUT OF FIVE MANUFACTURERS, 1910-1925

Chicago's meter problem due to the War Department order in the Drainage Canal diversion case that all services must be metered in ten years will be appreciated in part by the mere statement that, allowing for 6,000 new services each year some 40,000 meters must be set annually.

Hydrant-Flow Surveys: George H. Fenkell, general manager, water-works, Detroit, Mich.—In 1919-20 we made a hydrant-flow survey of the entire city of Detroit. It was followed by a plan for reinforcing all districts having a deficiency of supply. Much of this was accomplished by laying 8-, 10- and 12-in. mains, at a total expenditure of $2,000,000 in 1921 and after all betterments had been made as a result of this survey, a re-survey was undertaken that covered all of the areas found originally to have a deficient supply, and in no case did it appear that the additions to the system did not correct the deficiencies that had been noted.

The survey was made by three men from the water department and two from the fire department. The equipment included a number of pressure gages which could be read to pounds and which were mounted on hydrant nozzle caps, and several hydrant-flow pitot tubes which were connected to pressure gages which also read to pounds. The orifice of the pitot tube that was used was slightly less than ¾ in. in diameter and was mounted on the sharp edge of a knife blade brass casting about 4 in. long. This was connected to a brass tube about 12 in. long, and this in turn was connected to the pressure gage. This type of orifice and gage closely conforms to that used many years ago by John R. Freeman and is the type now in use by the National Board of Fire Underwriters. The coefficient of this pitot tube gage has been found to vary from 0.85 to 0.96, with an accepted average of 0.90.

The hydrants were divided into groups usually of four, and about 1,500 of these groups were investigated. The engineer in charge of the party was provided with a copy of a map of the distribution system and the groups that were to be investigated were laid out on this map in the field. The desirable and usual layout of a group provided a central hydrant from which the remaining three hydrants were visible. The engineer remained at the central hydrant and sent one of his assistants to each of the other hydrants in the group. The pressure gage was attached to the central hydrant and the water was turned on to this gage. The pressure indicated was recorded every 15 seconds for a period of one minute or until a representative pressure had been recorded. The engineer then signaled one of his assistants to open wide the hydrant at which that assistant was stationed and from which the hydrant cap had been removed, but the engineer would continue to record the pressure each 15 seconds noting on his record that the first hydrant had been opened. The assistant had previously measured and recorded on a form with which he had been provided the diameter of the hydrant nozzle. After the air had been expelled from the hydrant and the nozzle filled with water, the assistant placed the orifice in the center of the stream and recorded the pressure indicated on the gage mounted on the orifice pipe. The engineer, still recording pressures every 15 seconds, would then signal for the second hydrant to be opened. Then his assistant at the first hydrant would take a reading of the orifice gage when the second hydrant was opened. This procedure would continue until all hydrants in the group had been opened. If there were three opened hydrants in the group, the first assistant would have three flow readings to record. The second assistant would have two flow readings, and the third assistant would have one reading. When the hydrant had been closed finally, the engineer would record the pressure at the central hydrant. All gages were numbered and a record made on the sheets of the gage used for the recorded set of readings. The pressure gages were tested frequently and corrections were made on the last observed pressure for any error of registration.

The field records were turned into the office at the close of each day's work. The gallons discharged per minute from each hydrant was then computed from the observed pressures, and this information, together with the pressures obtained at the central hydrants, was posted on a large map. The formula that was used for converting the pressures as indicated by the gages into gallons discharged per minute is as follows: $26.8\ D^2\ \sqrt{P} =$ gal. per min. Here P is the recorded pressure in pounds as shown by the pitot tube gage, and D is the diameter in inches of the hydrant discharge nozzle. This takes into account the instrument coefficient 0.90 before mentioned.

As a fire engine is always used in Detroit when water

is taken from a hydrant for fire purposes, it was assumed that a residual pressure of 10 lb. on the central hydrant was sufficient when all of the hydrants in the group were opened wide. When the record sheets showed that the residual pressure exceeded 10 lb. per square inch, the results were recomputed so as to give the theoretical discharge of each of the hydrants for this pressure.

Each group of hydrants when posted on the office map was circled with ink to make it a visible unit. The types of building construction were indicated on the map by colors, and this made it possible to study the available amounts of water for fire protection in connection with the types of building construction in the areas or groups. Also from this information it was possible to arrive at some conclusion as to the amount of water that would be needed at each point to maintain reasonable service for ordinary uses. When the supply needed for fire protection and for regular consumption had been determined, it was then possible to determine the amount and the location of the reinforcement required, and that could be secured in the most economical manner.

Distribution Feeder Survey: V. Bernard Siems, water engineer, Baltimore, Md., and Edgar K. Wilson, chief engineer, Pitometer Co., New York—Maintenance and construction of the water distribution system in Baltimore is guided chiefly by the results of the routine pitometer survey conducted by the Conservation Sub-division of the Distribution Division. This pitometer survey is a nucleus about which are grouped other routine companion surveys which are also conducted continuously as an essential function of maintenance. Results of the various surveys, which are concerned with the interior as well as the exterior condition of the pipe system, are analyzed, and the actual physical condition of the pipe system and the actual performance of the distribution system ascertained. This information becomes the basis of new distribution design and with it the need for improvements or modifications and changes in the distributing system are known and applied. The companion surveys mentioned consist of the electrolysis survey, the valve survey, the pressure survey, and the fire flow survey.

Soon after the inauguration of this system of studying the actual performance of the distribution system under field conditions, it became evident that certain of the principal feeder mains were not functioning properly for the purpose for which they were designed. It also became evident that, through the analyses of the water waste, pressure, and fire flow surveys when correlated, indicated inefficient performance by the distribution system in certain cases, yet the specific cause could only be guessed; and, indeed, the data that could thus be collected to show the percentage of efficiency of the several mains was judged unreliable. A separate investigation of flow conditions at points indicated by the study of the regular maintenance surveys was decided on, using both the pitometer and loss-pressure gages. The Pitometer Co. was called upon for the necessary instruments and engineers to co-operate with our department in its investigation. In a period of about four months we covered a number of 16-in. to 60-in. mains, on which some 150 gaging points were located. We are certain from the results obtained that the cost of this work has been justified.

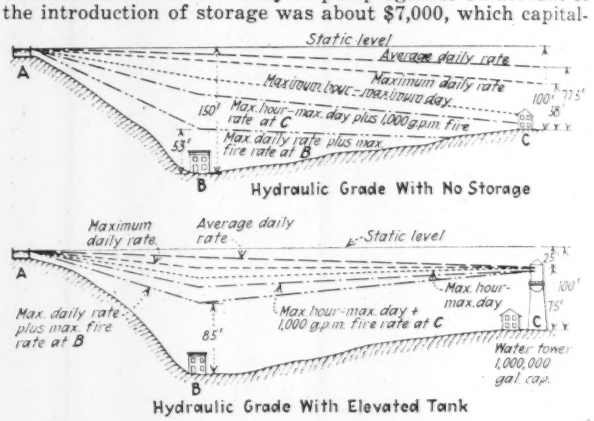
Feeder mains designed to perform important functions in the distribution system were found to be doing no appreciable part of the work contemplated for them, and consequently other mains were found with velocities higher than desirable. Had rule-of-thumb methods been adopted, instead of a more scientific basis for improvement design, these conditions might have led to the uneconomic addition of other mains to the distribution system for the purpose of carrying the necessary water not delivered by those mains working below capacity, or to relieve the load on those mains in which very high velocities were found.

About the same time that the distribution feeder survey was undertaken, the department inaugurated a water-main cleaning program to correct conditions of decreased feeder capacity. By cleaning we were able to restore the capacity of several important mains to approximately their capacity when new.

We have concluded that low pipe coefficients due to tuberculation may be expected in the very oldest mains in service, that cleaning is justified, and that cleaning may be the most economically performed in the case of large mains. We have also concluded that, although pipe capacities may be increased to equal approximately the capacity of new pipe, the expense of cleaning the water mains of small size as compared to the cost of installing new and larger pipes to replace the old mains in areas where the consumption is increasing, is not justified.

In general, the pipe coefficients obtained in our tests were less than are indicated by Williams and Hazen's tables for corresponding ages. This, however, was expected as the coefficient determinations were made with pipes under working conditions with valves, branches, bends, joints and other fittings in place. [Tables giving diameter, length, velocity, loss of head per 1,000 ft. and the coefficient found per 70 runs of pipe were given.]

Standpipes and Tanks to Equalize Distribution System Demands: N. S. Hill, consulting engineer, New York City—In a plant which I recently designed for Tampa, Fla., it was found that by spending approximately $85,000 for storage on the distribution system to take care of fire service and maximum hourly peak loads a saving of $407,500 could be effected in the cost of installation of a pumping plant, filtration plant and transmission main, or a net saving in the cost of installation of $322,000. The estimated saving in operating expenses by reason of the more uniform operation at the pumping station and the reduction in the head it was necessary to pump against on account of the introduction of storage was about $7,000, which capitalized at 10 per cent means an additional saving of $70,000 or a total saving of $392,000.



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Bridge Engineer, California Highway Commission

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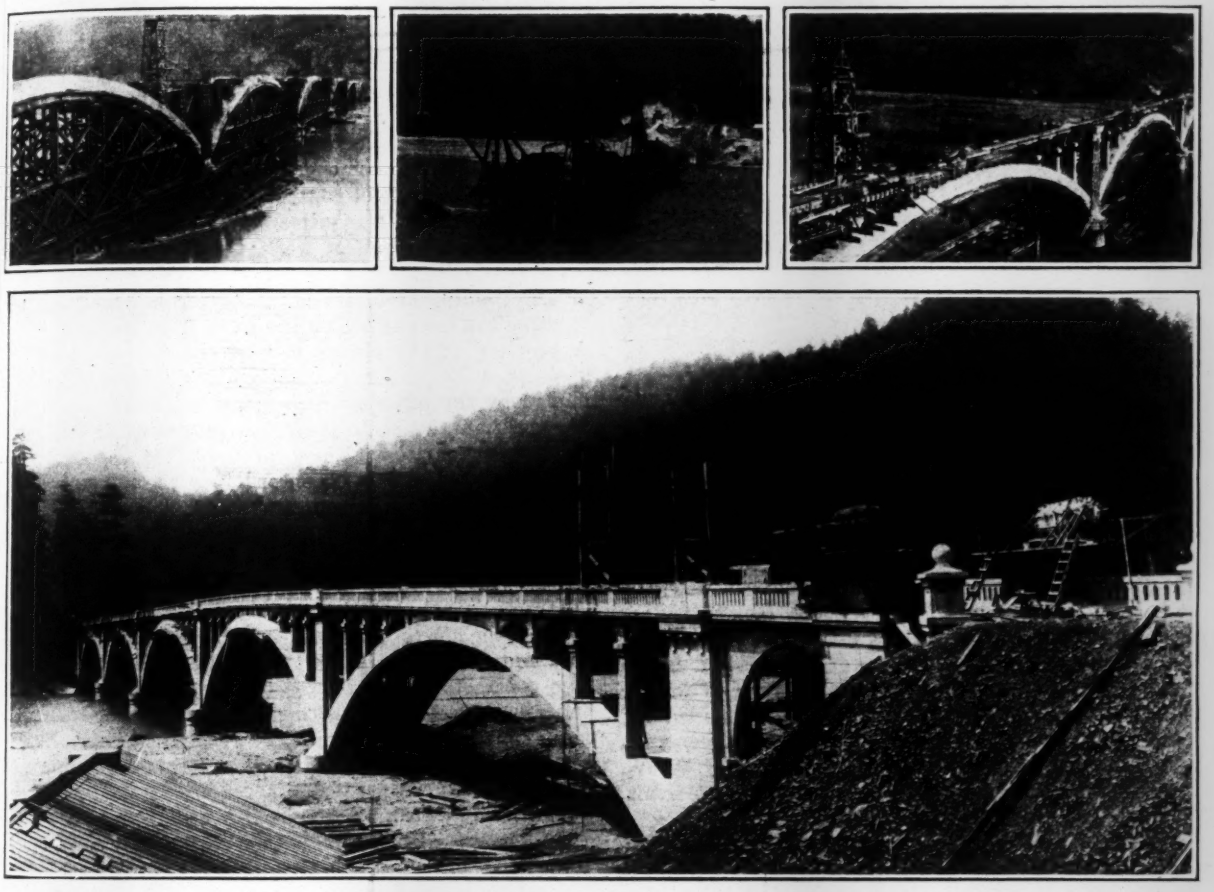

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The design of the bridge was fully covered in an article in *Engineering News-Record*, Sept. 25, 1924, p. 506, so that only a few notes on construction developments will be given here.

The bridge has a total length of 1,147 ft. It is made up of five main reinforced-concrete open spandrel arches, each 210 ft. long, together with short approach spans at each end of the bridge. The most difficult of the engineering problems encountered in the construction of the bridge was the building of the foundations. One abutment was on solid rock, but the other abutment and all four piers were founded in a sand and gravel formation, and were supported upon wooden piles. The bases of the piers were about 35 ft. below the surface of the water. Extra large fir foundation piles were used, pointed with cast steel shoes. All piles were driven to absolute refusal which was reached at varying penetrations of from 20 to 35 ft. below the concrete base of the piers or abutment. The pier bases were about 33x38 ft. in size and 165 piles, spaced 3 ft. by 2½ ft. on centers, were placed under each pier. The piles extended up into the pier bases varying distances from 3 to 10 ft. There were 308 piles used under the north abutment driven with a batter of 1 to 6 to help to resist the horizontal thrust from the arch ribs.

Because of the nature of the sand and gravel material the plans provided that the sheetpiling used by the contractor as a cofferdam should be left in place and that it should extend materially below the base of the foundations to prevent scour under them. For the north abutment and one pier heavy Wakefield wooden sheetpiling was used but steel sheetpiling was used around the remaining piers.

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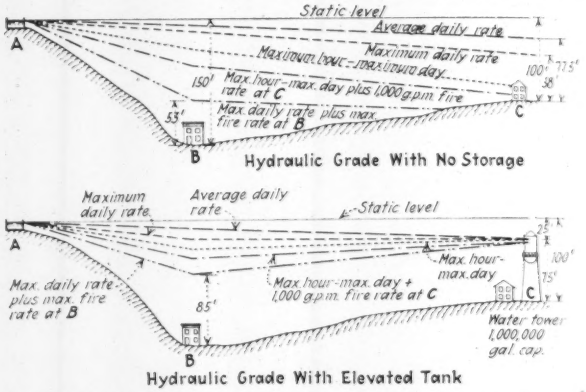

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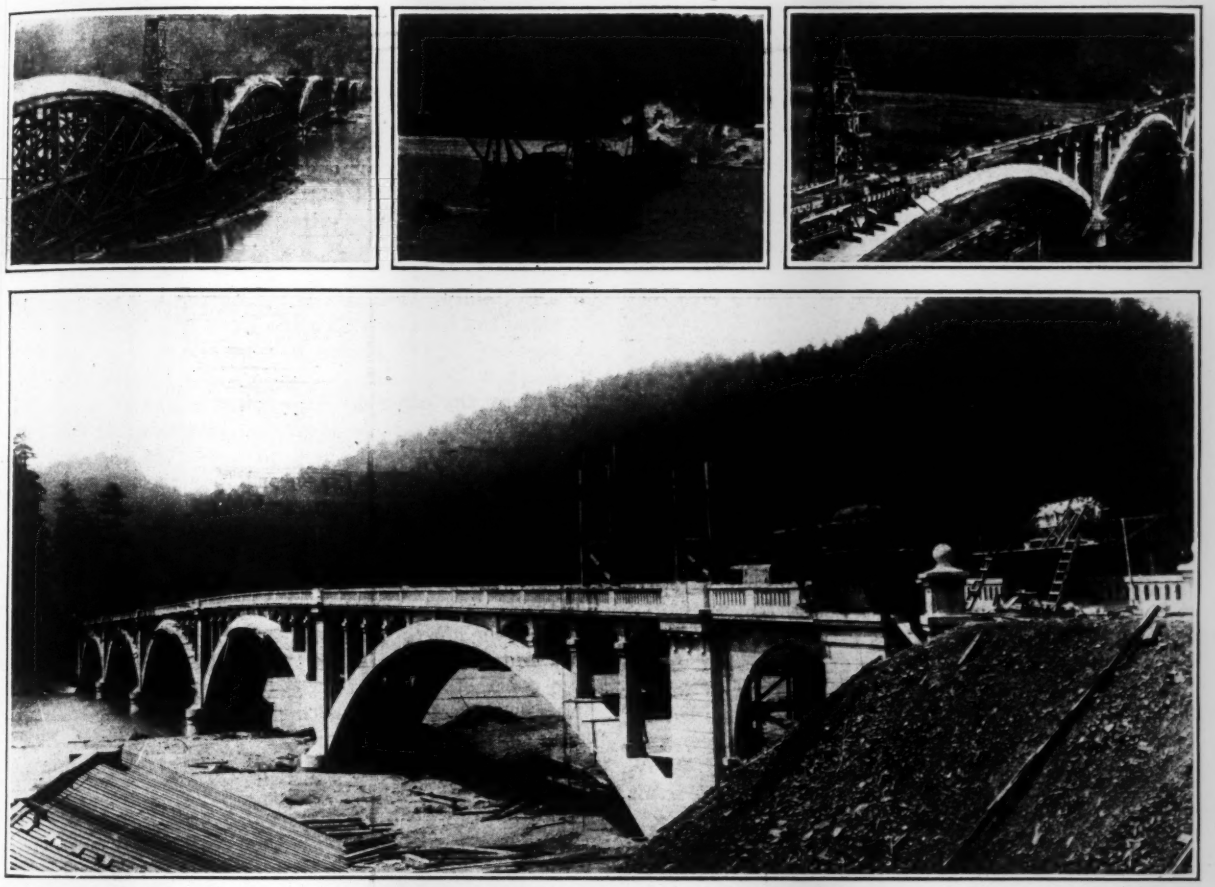

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A complete pouring diagram of all the concrete in the bridge was made a part of the plans. There were six key sections in each arch ring. These were left open until all the arches had been poured and then the keys in all five spans were poured as near simultaneously as possible. These keys were not poured until the last of the main arch sections had been poured at least 48 hours. The bulkheads used in the ribs to form the key sections were all built at right angles to the arch axis and projections three inches high were built on these bulkheads to form keys between the sections. Floor sections were poured symmetrically about the arch axis, none of the sections, however, being poured until after the arch centering had been struck.

The unit prices paid for the various items were:

Class "A" concrete (1:2:4)	$30.50 per cu.yd.
Class "C" concrete (1:3:6)	20.50 per cu.yd.
Reinforcing steel	.07 lb.
Excavation	6.00 per cu.yd.
Driving foundation piles (piles furnished free to contractor)	15.00 each

The contractor was F. Rolandi of San Francisco. The work was done under the supervision of the bridge department of the California Highway Commission, R. M. Morton, state highway engineer, and the writer, bridge engineer. The resident engineers on the work for the bridge department were S. Mitchell, J. C. Wilson and D. C. Willett.

Cost-Plus Adopted on River Des Peres Drainage, St. Louis

Flood Hazard and Trouble With First Contract Urged Change to Form of Contract Putting Risk on City

A DISTINCT departure in the letting of contracts for its public construction projects has been taken by the Board of Public Service, St. Louis, Mo., in calling for bids on June 22 for Sections B-2 and C of the River des Peres sewer project. The work advertised is expected to cost upward of a million dollars and will be contracted on a cost-plus basis. The conditions leading to this innovation and the nature of the special contract, as outlined for *Engineering News-Record* by W. W. Horner, chief engineer, sewers and paving, St. Louis, Mo., are:

The River des Peres drainage works is an $11,000,000 project inside the city of St. Louis, and is one of the items of the $87,000,000 bond issue voted in 1923. The project as a whole will consist of enclosing about four miles of the upper portion of the River des Peres in a large combined sewer of reinforced-concrete sections running up to 32 ft. in size. For the lower ten miles, the construction consists of an open flood-way channel of trapezoidal type, the lower portion paved with concrete or riprap, and, beneath the floor of the channel, an intercepting sewer. A portion of the intercepting sewer, in particular the lower five miles, was built in 1910 under another bond issue, and the present construction work was started at the upper end of this section. The contract for the first mile known as Section A was let to the Higgins-Wall-Dyer Co., on a straight unit price contract, on a bid considerably below the city's estimate, which was also considered low. The company was unable to make progress and the work was completed by the J. J. Dunnegan Construction Co. on a force-account basis. This company also constructed an extension of this section, so that about 1¼ miles of work are now complete.

The next contract known as Sections B and C, approximately two miles in length, is now being advertised, and this is the section on which the new contract form is to be tried. Like the first section, the work must be done almost entirely in the bed of the river and is subject to interruption and damage by floods. After the experience with Section A, the city's engineers came to the conclusion that any contractor bidding on Sections B and C, on a unit price basis or at a guaranteed amount, would unquestionably add 20 to 30 per cent for contingencies. As the city was desirous not only of having the work done at a reasonable figure, but of securing the most rapid progress compatible with reasonable cost, the Board of Public Service was advised to adopt a cost-plus type of contract carrying with it the determination to award the contract only to a well established, experienced, and financially able contractor. This recommendation was approved by the board, and the present contract form drawn up.

The advertisement requires bidders to name unit costs for each classification of work, these costs to cover all prorated charges but not to include certain contingencies or any item of profit. The contractor is also required to name the time in which the work is to be completed. A proposal of the bidder naming the shortest time is used as a basis for calculation, the additional time named by the other bidders being evaluated at $2,000 per week and added to their cost estimate for the purpose of comparison. The board reserves the right to reject any bid and is on record that the contract will only be awarded to a well established, experienced, and financially able organization.

On completion of the work, a final estimate of quantities will be made. This when extended by the contractor's bid cost becomes the basis of determining the fee, the city in the meantime having paid the actual cost and expense of the work as the work progresses. The contractor normally receives a 10 per cent fee on the final quantity-cost estimate. If the actual cost is less than this final estimate, he receives also one-third of the savings. If it is in excess of this estimate, the normal fee of 10 per cent is reduced 1 per cent for approximately each 5 per cent of over-run in cost. The time element also enters with a $2,000 a week bonus or penalty based on the time originally named by the contractor in his bid.

It may be of interest to know that the actual contract form used is the new municipal contract form, with slight modification, recently approved by the Joint Committee of the American Society for Municipal Improvements and the Associated General Contractors of America. This joint contract form is based on unit prices. It will be submitted during the coming year to the two societies for adoption as a standard. For the River des Peres work, those portions of the contract relating to determination of payment were necessarily altered.

It is also proposed to apply this form of contract to another section of the River des Peres drainage works, known as Section J, where the same construction hazards on account of floods exist, but the city has no intention of departing from its unit price standards on any of its other sewer work or paving work.

Fire Test of Light-weight Floor of Poured Gypsum Concrete

Floor Slab Cast on Permanent Centering of Wall Board—Poured Ceiling Slab Proved to Be Efficient Fire Protection

By A. H. Beyer
Director of Testing, Columbia University Testing Laboratories, New York City

BEFORE any new type of floor and roof construction can be used in fireproof buildings in the city or state of New York it must pass the following test:

At least one panel of the proposed maximum span carrying a live-load of at least 150 lb. per sq.ft. shall be subjected to a fire continuous for four hours at an average temperature of 1,700 deg. F., followed by the application, for not less than ten minutes, of a hose stream from a 1⅛-ft. nozzle at 60-lb. nozzle pressure without appreciable deterioration or the passage of flame through the floor during the test. In addition, the floor must sustain, after the test, a uniformly distributed live-load of 600 lb. per sq.ft., without exceeding a stated permanent deflection.

The above rigid provisions, with the possible exception of the severe loading of the test floor after it has been subjected to fire and water, are sound and have been, undoubtedly, an important factor in promoting safe and sane fireproof construction. Designing to meet the strength requirements is less difficult than providing the fire-resistance demanded by the test; a thorough knowledge of the fire-resistant properties of materials is necessary in order to obtain adequate fire-resistance economically. This is particularly true in the case of light-weight floors, for which there is a growing demand, and it has been charged that the specified test is too severe. But the excellent results recently obtained in a test of a gypsum slab floor prove that it is entirely

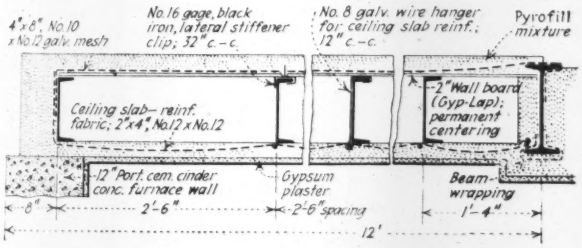
4"x6", No.10 x No.12 galv. mesh
No.16 gage, black iron, lateral stiffener clip; 32" c.-c.
No. 8 galv. wire hanger for ceiling slab reinf.; 12" c.-c.
Pyrofill mixture
Ceiling slab—reinf. fabric; 2"x4", No.12 x No.12
2" Wall board (Gyp-Lap); permanent centering
12" Port. cem. cinder conc. furnace wall
Gypsum plaster
Beam-wrapping
8"
2'-6"
2'-6" spacing
1'-4"
12'

FIG. 1—CONSTRUCTION OF LIGHT FLOOR FOR TEST

possible to obtain high fire-resistance in light-weight construction, and thus show that the test is by no means so severe as to hinder development in this field. This will be seen from the following outline of the test results:

Gypsum Floor—The test floor was a composite structure of floor slab and ceiling carried by steel beams. The floor slab was 2½ in. thick, poured in place, made of "Pyrofill" (a porous gypsum concrete) reinforced with rectangular wire mesh. Gypsum wall boards laid on the beams formed a permanent centering. The steel supporting members were channels spanning 15 ft. and spaced 30 in. apart. They were designed for a live-load of 150 lb. per sq.ft. and had their compression flanges stiffened against lateral buckling by clips secured to the floor slab. A reinforced "Pyrofill" ceiling slab 2½ in. thick, also poured in place, was suspended from the lower flanges of the channels, providing the necessary fire protection to the channels and floor slab proper. The ceiling was surfaced with a three-coat gypsum plaster. The construction was designed and built by the United States Gypsum Co., of Chicago.

The material "Pyrofill," which is the essence of the test floor, is made by mixing a prepared gypsum product known to the trade as No. 1 Stucco, with wood shavings and water. In construction the test floor, 200 lb. of the prepared gypsum were mixed with 55 lb. of water, to which 24 lb. of wood shavings were added. This material begins to harden in about 8 min. It developed a compressive strength of 590 lb. per sq.in. and a modulus of elasticity of about 260,000 lb. per sq.in., which is based on six tests made on 6x12-in. cylinders.

Before the test, the floor was loaded with pig iron

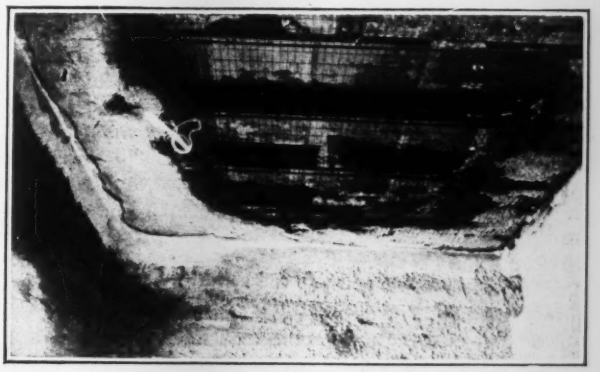

FIG. 2—UNDERSIDE OF CEILING SLAB AFTER HOSE-STREAM WAS APPLIED
Gypsum concrete calcined in four-hour fire test largely washed away by 60-lb. stream; steel beams and plaster board centering of floor slab passed through test uninjured.

to 150 lb. per sq.ft. The furnace was operated in accordance with the standard time-temperature curve for fire tests; it reached 1,700 deg. F. in the first half hour and attained a maximum of 1,891 deg. F. The center deflection under load was 0.26 in., and this increased to 0.38 in. as a result of the four-hour fire and ten-minute water application.

Fire Test—The ceiling slab proved to be an efficient fire protection. The plaster finish spalled off completely in the first five minutes of firing, and therefore was not a factor in fire protection. The temperature of the lower flange of the channels (measured at two points) reached, after four hours of firing, 202 deg. and 205 deg. F. respectively, thereby indicating that the ultimate resistance to fire of the ceiling slab had not been reached. The upper surface of the floor (measured under 6x6x½-in. asbestos pads) averaged 124 deg. F., with a maximum of 132 deg. F. at one point.

Water Test—Application of a hose stream under 60 lb. nozzle pressure to the underside of the construction washed away the partially calcined ceiling slab, leaving the reinforcement, the channels, and the underside of the wall board centering of the floor slab exposed. The floor slab and the structural framework were found to be unaffected by the fire and water, and when the test floor was loaded (after the water test) to 600 lb. per sq.ft. its total deflection became 1.04 in., increasing to 1.21 in. after twenty hours. On the removal of the load, the permanent deflection in the test floor was found to be 0.38 in.

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It has been urged that what we really desire is safety under the extreme service conditions that may be possible or probable; and that any expenditure of material beyond this point is unnecessary. On this principle the system of ultimate designing is developed. It consists in nothing more than estimating the *most unfavorable service conditions* that can occur (instead of the normal conditions) and proportioning the structure to survive these extreme conditions with no margin of strength—or with a slight margin, just enough to assure survival.

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Just at the moment interest in the book is heightened by a proposed new charter for Minneapolis in the framing of which Professor Anderson has figured largely. For the most part the charter squares with the teachings of this volume but it contains one feature not described in the book and at variance with it: An elective board of financial review which, once set in motion by a hundred taxpayers, on petition, can override the city council on all important financial matters except those which have been subjected to a referendum. Evidently, as pointed out editorially in our columns for June 10, 1926, p. 929, this feature is a result of a "compromise" between a representative of "business men" and Professor Anderson, in which the latter seems to have got about everything he would be expected to stand out for, but lost on this.

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DIE DEFORMATIONSMETHODE—By Dr. tech. h.c. A. Ostenfeld, Professor au der Technischen Hochschule, Kopenhagen. Berlin: Julius Springer. Paper; 6x9 in.; pp. 118; 42 line cuts. Paper 10 marks, gold, in Germany.

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UNTERSUCHUNGEN ÜBER DEN EINFLUSS HÄUFIG WIEDERHOLTER DRUCKBEANSPRUCHUNGEN AUF DRUCK-ELASTIZITÄT UND DRUCKFESTIGKEIT VON BETON—By Dr.-Ing. Alfred Mehmel. Berlin: Julius Springer. Paper; 6x9 in.; pp. 74; 30 line cuts. Paper, 6.6 marks, gold, Germany.

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Economy in Contract Work by More Uniform Basis of Bids Is Aim of New Association

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That one of the first activities of the new organization will be the determining of some fundamentals in principle and practice was indicated by the general discussions. Tentative definitions of "quantity surveying," "cubage of structures" and "classification of structural types" were submitted, and after discussion from various points of view were left for reference to committees to be appointed later. In calling attention to the importance of these matters, the chairman, Mr. Brunner, pointed out that the object of the quantity surveyor must be to give the contractor what he wants in preparing his estimates and not a lot of miscellaneous information. Furthermore, with the increasing use of cost accounting systems by contractors, the quantity survey must be presented in such form as to tie in with the accounting system. On the questions as to whether the survey should be tabulation of physical units or material quantities, there was again difference of opinion. For instance, should maple flooring be simply listed as so many square feet of floor, or should it be listed as the amount of material to cover that area. In concrete, it was assumed that the yardage would be given; it being up to the contractor to determine how much cement and aggregate he would need to produce that yardage.

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association to have the full-time service of Secretary Little, now superintendent of water-works at Rochester, N. Y.

Additions of a Montana and a Rocky Mountain section brings the membership of geographical sections up to 14. The Hill Cup, provided by N. S. Hill for award annually to the section showing the largest growth during the year, was retained by the California section which raised its membership from 120 to 156 during the year.

Ban on Cross-Connections

Adoption by the Fire Protection Division last year at the Louisville convention of a resolution favoring the abolition of all cross-connections was approved by the association as a whole. The division voted this year to ask the executive committee to consider action looking to the prohibition of auxiliary intakes to possibly polluted sources of supply and of by-passes at purification plants. This cross-connection subject presented also in a paper by C. A. Holmquist, detailing progress in cross-connection elimination in New York State, led to a heated discussion brought about by four doughty champions of control rather than prohibition of cross-connections who came from Boston to represent fire insurance interests, particularly the Factory Mutual Companies. Nothwithstanding their hour-long arguments, which included a defense of the integrity of the special double check valves, the resolution for the abolition of cross-connections stands as adopted.

A resolution was adopted denouncing interference by elected officials in the work of administrative officers and advocating the selection and retention of technically trained men for such positions.

George W. Fuller, chairman of the Standardization Council stated that having produced the book called Manual of Water-Works Practice and overseen the production, jointly with other societies, of a new edition of Standard Methods of Water Analysis his council was going to let the members take the initiative for a while. Of 2,700 copies of the Manual all but 200 have been sold. A second printing, with corrections only, will be made soon. The Health Section of the League of Nations has ordered Standard Methods translated into French and German and is considering translations into Spanish and Portuguese. Mr. Fuller commended the activities of the Committee on Boiler Feed Waters, of which S. T. Powell of Baltimore is chairman. Mr. Powell reported joint action with the Am. Soc. M. E. and other organizations, represented on the current program by 9 or 10 committee reports and papers, all of which will soon be pre-printed in *Journal* Am. Soc. M. E. and be up for discussion at the New York meeting of that society this fall.

Standard Specifications

The Joint Committee on Standard Specifications for Water Meters, reported that as a result of a questionnaire to 34 large cities using hundreds of thousands of meters it had been concluded that any attempt to standardize round dials would be futile. Hope for future standardization of straight-reading dials was expressed. The committees on Standard Brass Fittings and Standard Contracts reported progress.

The Committee on Standard Specifications for Cast Iron Pipe, through Frank A. Barbour, Boston, chairman, reported the organization of a large joint committee under the auspices of the Engineering Standards Committee (see this journal March 4, p. 375, and April 29, p. 706.

Fire Prevention

The Joint Fire Prevention Committee, F. C. Jordan, Indianapolis, chairman, reported successful fire prevention campaigns in several cities. On the program of the Water Purification Division were progress reports of the following committees of the Standardization Council: Standard Methods of Water Anlysis; Practicable Loadings for Purification Processes; Industrial Wastes in Relation to Water Supply; Filter Sand Testing and Recording.

Three issues of *Engineering News-Record Waterworks Daily* appeared during the convention, the last one containing complete alphabetically arranged lists of the active and associate members who had registered to date. Notes on the exhibits appear on p. 1002 of the Manufacturers Section of this issue.

Large City Planning and Survey Committee for New York City

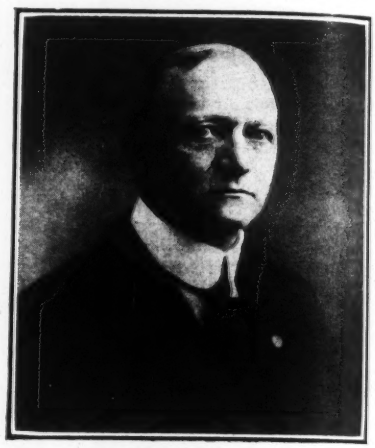
A City Planning and Survey Committee of 475 members has been appointed by Mayor Walker "to make a survey of the City of New York and plan for its future needs." The committee will meet for organization June 21. Besides an executive committee there will be seven sub-committees, as follows: (1) On Housing, Zoning and Distribution of Population. (2) Port and Terminal Facilities. (3) Traffic Regulation and Street Uses. (4) Sanitation and Harbor Pollution. (5) Highways and Bridges. (6) Parks and Recreational Facilities. The appointees include many engineers, both within and outside of the New York City departments, architects and landscape architects, manufacturers, contractors, lawyers, social workers, a boxing commissioner and representatives of many other groups.

New Railroad Into Colorado

The Dodge City & Cimarron Valley Railway Co., a subsidiary of the Atchison, Topeka & Santa Fe Railway Co., has been authorized by the Interstate Commerce Commission to construct a single-track railway line from Manter, in Stanton County, Kan., in a general westerly and southwesterly direction to a point near Joycoy, in Baca County, Colo., a distance of approximately 56 miles. The new railway is to serve an agricultural and grazing area about 100 miles square which is without railway service at the present time. The estimated cost of the extension is $1,890,000. It is expected that construction will be started at once and will be completed before June 30, 1927.

New President of A.W.W.A.

Allan W. Cuddeback, the newly-elected president of the American Waterworks Association, is a native of Cuddebackville, N. Y., and a graduate of Leland-Stanford, Jr. University in the Class of 1894. He began his practical training in the waterworks field as a leveler for the East Jersey Water Co. on water supply work for Newark, N. J., before graduating from college. After graduation he was employed for



A. W. Cuddeback

a short time on plans for a sewerage system for Palo Alto, Calif., and then with the U. S. Coast and Geodetic Survey on the boundary line between California and Nevada. In 1896 he returned to the New Jersey Water Co. on further work for the Newark water supply, later going to the Passaic Valley Sewerage Commission, and then for a short time to the City of New York on topographical surveys. From 1897 to 1898 he was with the Metropolitan Street Railway Co., and in 1898 he returned to water supply work as assistant engineer with the Passaic Water Co., at Paterson, N. J.

Mr. Cuddeback, who is now vice-president and engineer of the Passaic Consolidated Water Co., has served that company and its associated companies as assistant engineer, assistant superintendent, superintendent and engineer for 28 years.

Obstacle to $100,000,000 Road Fund Removed in Illinois

The last legal obstacle to the completion of the Illinois road work included in the $60,000,000 bond issue budget was removed June 10 by a decision of Circuit Judge E. S. Smith at Springfield, Ill., who held that the state had not exceeded its authority by selecting a road skirting Pontiac instead of passing through the city. About 90 miles of work under this bond issue has been held up pending negotiations on right-of-way. This work will be let within the next two months, and the state highway department will then be ready to proceed with work under the $100,000,000 bond issue passed last year.

Failure of Lock on Portage Canal, Wisconsin

Timber Wall Falls but Gate Holds for Emergency Repairs—Concrete Lock to Be Built

Failure of the old lock at Portage, Wis., on the Portage Canal connecting the Fox and Wisconsin rivers, has produced a situation so serious that the War Department is reported as undertaking early replacement of the old timber structure with a new concrete lock. The present lock, 35 x 143 ft., built in 1893 by the War Department, replaced an old structure built by a private company some time prior to 1872, when the U. S. Government assumed control of the rivers. It has only upper and lower gates, with no guard gate. The following account of the accident is from information furnished by H. V. Tennant, of the General Engineering Co., Portage, Wis., who is also in charge of the Portage levees under direction of the State Engineer of Wisconsin.

On April 17, when the Wisconsin River was practically at flood stage, the lock gates were opened to allow a number of large launches to pass through the canal to that river; after they had passed, the water was again lowered in the lock chamber. This raising and lowering of the water caused a pressure on the chamber walls which resulted in the collapse of the west side of the lock chamber. The part which fell into the canal carried away the abutments and masonry which held the hollow quoin of the upper gate in place. There was a head of 8 or 10 ft. on the upper gate at this time, and with the support of the masonry withdrawn, the lock gate and hollow quoin started to fall. By good fortune, however, a large slab of concrete sidewalk from the top of the lock wall had fallen into the lock chamber and lodged in such a manner as to brace itself against the gate and the hollow quoin. This temporarily prevented the collapse of the upper gate and while the structure was apparently ready to collapse it remained in place until it could be made secure by cables and other temporary expedients.

Emergency Repairs

In the absence of the government engineer Mr. Tennant took charge of the situation and effected emergency repairs with stone and sandbags, thus making the gates temporarily secure. If the upper gates had given way, it is considered certain that the rush of water into the lock chamber would have swept away the remainder of the west chamber wall, as well as the lower gates. This would have resulted in a serious flood in the small Fox River valley, as full flow of the Wisconsin River would have gone down that valley. There was at that time about 16 ft. difference in elevation between the water surface in the Wisconsin River and in the Fox River, about 1½ mile distant.

The old lock was entirely of timber construction, the walls of the chamber being made of timbers tied into the earth back of the bank with tie rods secured to piling. Immediately behind the timber wall was a loose masonry drywall, but this was little more than a pile of loose stones filled in behind the timber. Within the last three or four years, the timber wall had been relined with 2-in. planks, which gave it the appearance of being in very good condition, but the main timbers were old and largely rotted, so that the structure was in a weak condition.

It was planned at first to repair the old lock gates and to rebuild the walls in timber construction similar to the old structure. However, the citizens of Portage felt that this type of construction would only be safe for a few years and that another failure might occur with much more serious results. They made a direct appeal, therefore, to the War Department and the Chief of Engineers, asking for replacement with a concrete structure which would be permanent and would eliminate further danger from this source. As a result plans are now being made for a concrete lock which is expected to replace the old timber structure within the next few months.

Ontario Increases Amount of Road Building Fund

The Ontario Government, which earlier in the year decided upon a program of road construction involving a cost of slightly under three million dollars, has decided on a further outlay of about $500,000. Additional expenditures are in contemplation, as a number of bridges may have to be built later in the year, which may bring the total outlay up to $5,000,000. Last year's expenditure was $5,500,000.

New Building Code for Ohio

A statement by the Ohio Board of Building Standards explains that under the law creating this Board it is required to submit revisions of the present State building code, and that some of the most glaring defects were remedied at the recent session of the legislature. Public hearings have been arranged for discussion of a complete new code at meetings in different cities during June and July.

Prizes Awarded in Competition for Copenhagen Bridge Design

Three prizes have been awarded for the best design for a high-level bridge across Copenhagen harbor, Denmark. The international competition announced some months ago brought out 33 designs. First prize, in the amount 15,000 kronen, was awarded to Prof. A. Rosen, architect, and C. B. Petersen, engineer, both of Copenhagen, working in co-operation with the Gutehoffnungshütte of Oberhausen, Germany. Two prizes of 10,000 kronen each were awarded to Dr. C. Nokkentved and S. F. Jespersen, of Copenhagen; and to Christiani & Nielsen, contractors, of Copenhagen, and the Maschinenfabrik Augsburg-Nürnberg, of Gustavsburg, Germany, working in co-operation with Prof. Kai Gottlob, of Copenhagen, architect. The jury also recommended the purchase for 2,000 kronen of a design prepared by Monberg & Thorsen, of Copenhagen, working in co-operation with Prof. Karl Wach, of Düsseldorf, Germany, architect, and the Flender Bridge Works, of Benrath, Germany.

NEW DAM ON CRUSE RIVER COMPLETED

THERE has been completed recently a new dam on the Cruse River, near Eguzon, France, for the development of hydro-electric power. The above picture shows the dam partly completed. The maximum height of the completed structure is about 200 ft. The reservoir formed behind the dam will be approximately 11 miles long and three-tenths of a mile wide at the widest point. The power to be developed at the site will be approximately 100,000 hp.

C. J. Ullrich Elected New President of A.A.E.

C. J. Ullrich, a member of the firm of McGonagle & Ullrich, consulting engineers, Salt Lake City, Utah, has been elected president of the American Association of Engineers for the ensuing year, to succeed Dr. D. B. Steinman. Mr. Ullrich is a native of Michigan City, Ind., and a graduate of the University of Michigan in the Class of 1906. He began engineering work with

C. J. Ullrich

the Leonard Construction Co., of Chicago, upon graduation from college. In 1909 he became superintendent of construction for all work above ground for the Superior Coal Co., of Superior, Wyo., and in 1911 became resident engineer on the construction of the Idaho Falls Municipal Hydro-Electric Plant and Pumping Station on the Snake River. In 1912 he became office engineer for the Utah State Roads Commission, and the following year was appointed deputy state engineer of Utah, which position he held until, in 1921, he became a member of the firm of McGonagle & Ullrich.

Mr. Ullrich also is an attorney-at-law, having been admitted to practice in 1917 in the State Court of Utah, and the Federal Court in 1921. He confines his legal practice to engineering matters entirely.

Quantity Surveyors Form a New Organization

(*Concluded from p. 997*)

ton, presented a suprisingly long and varied list of this class.

After the constitution had been submitted, discussed and adopted, officers for the first year of the American Institute of Quantity Surveyors, were elected as follows: President, W. F. Jackson, Birmingham, Ala.; first vice-president, C. L. Weeks, Los Angeles, Calif.; second vice-president, Oscar Euphrat, Cincinnati, Ohio; secretary, C. T. Burman, Chicago; treasurer, G. Sjmak, Bridgeport, Conn.

Delegates from Every State at A.A.E. Convention

Association Works Under Active Conditions at Philadelphia—Reaches Sound Condition

(*Engineering News-Record Staff Report*)

More than a hundred delegates and members are in attendance at the annual convention of the American Association of Engineers being held at Philadelphia during the current week, all states of the United States—there is also a delegate from Honolulu—are represented. The major work of the meeting is consideration of reports of standing committees of the association. Questions of practice, registration, competition and fees are demanding much discussion. The internal affairs of the association, which have been prominent at the conventions of the past two or three years, are not prominent this year, however. A stable, sound condition of membership and finances appears to have been reached. After many internal difficulties and marked decrease in membership during the past two years or more, the curve of membership is again rising slowly, with a present figure of about 6,500, of whom nearly 5,300 are above student grade. The finances have been brought to a satisfactory condition by thrifty management.

Retiring President D. B. Steinman put the tone of the convention on a high plane at the beginning by an address of remarkable strength, under the title, "Our Profession." His theme was that every man is a debtor to his profession, and he urged from the association that it make it its principal duty to increase the heritage received by the present generation from the engineers who have preceded.

Registration of Engineers

Registration was a subject of particularly active discussion at the sessions of the convention. There is decided dissatisfaction, it appeared from the comments of various objectors, with the working of the licensing laws in several states, notably Pennsylvania where the administration appears to be distinctly bad. Some proposals were made that registration laws of unsatisfactory character where not helpful in their working should be repealed. In opposition to this view, however, it was brought out that the present difficulties in the working of the laws—in particular due to the grandfather clause—must be tolerated and that the major function of the registration laws is to build an engineering profession for the future. This view was expressed in a particularly forcible way by O. Laurgaard, city engineer of Portland, Ore., and chairman of the Oregon registration board.

C. J. Ullrich, consulting engineer, Salt Lake City, was elected president of the association for the coming year. W. R. Harris and D. M. Baker were elected vice-presidents. The new directors are: J. M. Buswell, C. W. Cross, V. H. Cochrane, C. S. McKee, H. G. Culverhouse, E. G. Haines, and J. Denison.

RANDOM LINES

Quite a Long Dam ! !

"The opening of the dam is the first step in an ambitious plan to harness the river power of Massif Central and provide a sufficient quantity of 'white coal' for the electrification of all the railways and supply electricity for the whole district of Paris. The dam is eleven miles long and in places five-eighths of a mile wide and its holding capacity is about 13,500,000,000 gallons."

From a wireless dispatch to the *New York Times*. For more exact details see the picture of the dam under construction on p. 999.

* * *

Accommodating Water

Herbert Janvrin Brown, "meteorologist," has found another way to enlist the Mid-West farmer for the inland-waterway campaign. "The Great Lakes to Gulf waterway" he said in an address the other day in Chicago "will add $10 to the value of every planted or grazing area west of the Mississippi. . . . The water from the Great Lakes flowing into the Gulf of Mexico will swing to the right and be carried in the form of moisture by the monsoon winds back over a 50-mile stretch of country up and down the Mississippi valleys."

* * *

How Water Is Used in California

Sir—Enclosed is a clipping from the *New York Sun*, in which you may be interested and which shows how they do it in California.

"Schenectady, May 27.

"An unusual feature of the project will be the ratio of storage capacity to yield. At the main Bucks Creek reservoir there is an estimated annual run off from the water sheds above the dam of 72,000 acre feet. In order to control this run off a storage capacity of 103,000 acre feet will be provided. The average total yield through the power house will be 114,000 acre feet per year, and this will produce 205,000,000 kilowatts." W. M. C.

* * *

Rating the Engineer

A delegate to the Master Plumbers' Association convention in Los Angeles a few weeks ago suggested that young men entering the plumbing business be henceforth referred to as "sanitary engineers" instead of as plumbers' helpers. Discussion from the floor of the convention, says the Los Angeles *Evening Express*, "revealed that the majority of delegates were in sympathy with this move to elevate the tone of the profession. Sanitary engineers, it was asserted, would sound infinitely better than plumbers and would place the business on a par with bricklayers, stonemasons and other craftsmen."

Senate Passes Bill Appropriating $165,000,000 for Highways

By a vote of 63 to 6 the Senate on June 11 passed the Federal-Aid highway bill. It authorizes an appropriation of $75,000,000 for the next fiscal year and a similar amount for the succeeding fiscal year. In addition, $15,000,000 is authorized for forest roads and trails.

The Senators who voted against the bill on final passage were: Bingham, Connecticut; Edwards, New Jersey; Gary, Rhode Island; McLean, Connecticut; Metcalf, Rhode Island; and Moses, New Hampshire.

The bill was passed by the House on April 16. As this is written, it is before the President for signature.

Denver Plans Power and Storage Projects on South Platte

The city and county of Denver have applied to the Federal Power Commission for a preliminary permit covering a project on the South Platte River to provide water for municipal use and to develop power.

The development includes six reservoirs with a total capacity of 443,200 acre-feet. It is proposed to build a power house at each reservoir. The amount of power to be developed and the height of each dam and the storage is as follows:

Reservoir	Power Kilowatts	Height of Dam in Feet	Acre-Feet
American.....	4,500	228	80,000
Cheeseman.....	6,750	212	79,000
Deckers.....	6,000	130	2,900
Two Forks.....	18,000	333	262,000
Strontia.....	12,000	156	1,800
Intake.....	12,000	228	17,500
Total.....	59,250		443,200

National Lime Association in Annual Convention

The Eighth Annual Convention and the twenty-fourth annual meeting of lime manufacturers held at French Lick, Indiana, June 8-11, combined technical and popular discussions of problems of interest to manufacturers and users of lime.

The subjects discussed and the speakers were as follows: "The Market for Lime," by Irving G. Fellner, Business Manager, *Chemical and Metallurgical Engineering*: "Economical and Substantial Construction," by John H. McClatchy, Philadelphia; "Balanced Publicity," by R. P. Brown, manager publicity department, N.L.A.; "Lime in the Industrial Field," by L. B. Burt, Manager Industrial Department, N.L.A.; "The Uses of Lime in Construction," by J. S. Elwell, manager, construction department, N.L.A.; and "Practical Aspects of Research," by G. J. Fink, director, Association Laboratories, N.L.A. The uses of lime in concrete and asphalt highway surfacing and in the treatment of dirt roads were described by C. R. Stokes, manager of the highway department and by H. W. Wood of the same department. Practically the entire attendance participated in the two round table conferences, the first of which was devoted to problems of manufacture and the second to the properties and uses of lime.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 14-17, New York City, June 18-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The Minnesota Federation of Architectural and Engineering Societies has arranged an international mid-continent engineering convention to be held at Duluth and on the Mesabi iron range Aug. 12 to 14. Technical papers and visits to mines and industries will be included, as well as special entertainment. W. H. Woodbury, Wolvin Building, Duluth, Minn., is in charge of arrangements.

A joint outing of the New England Water Works Association and the Boston Society of Civil Engineers will be held on June 22 at the New Ocean House, Swampscott, Mass.

The Engineers' Club of Baltimore at its annual election held June 3 elected as president, C. C. Cook, of the Baltimore & Ohio R.R. engineering department; vice-presidents, Norman A. Hill and J. U. Bragg; treasurer, W. A. Wood (re-elected).

Personal Notes

DR. ELWOOD MEAD, the Commissioner of Reclamation, Washington, D. C., left Washington June 14 for a visit to some of the government's land reclamation projects, making brief stops at New York and Detroit. Dr. Mead will address the American Society of Agricultural Engineers at its meeting later in June at Lake Tahoe, Calif., on the development of the lower Colorado. He will return to Washington about July 2.

FRANK R. DUNLOP, formerly with the J. Henry Miller Construction Co. of Baltimore, Md., has gone to Washington, D. C., as construction manager on the National Press Building for the George A. Fuller Construction Co. Mr. Dunlop joined the Fuller organization in January as assistant to the vice-president. During the World War he was a construction engineer in the Navy Department in charge of the construction of the Navy and Munitions building.

A. G. RIPBERGER, until recently assistant general superintendent of operations of the United Alloy Steel Corporation, has been appointed chief engineer of that company, covering all its divisions.

F. E. WEYMOUTH has been engaged by the J. G. White Engineering Corporation as chief engineer for their work in Mexico. He suspends his work as active head of Brock & Weymouth, Inc., Philadelphia, Pa., but remains a director and consultant of the firm.

MILO S. KETCHUM, dean of the College of Engineering, University of Illinois, received the degree of doctor of science at the annual commencement of the Colorado School of Mines, after delivering the commencement address on the subject, "The Engineer as a Professional Man."

HOLTON D. ROBINSON, of the firm of Robinson and Steinman, consulting engineers, New York City, received the degree of doctor of science from St. Lawrence University June 8; he is a graduate of this college.

J. LEROY UNDERHILL, assistant to the manager of the Vermont Lighting Corporation, has been appointed superintendent of the St. Albans division with headquarters at St. Albans, Vermont.

CHARLES M. UPHAM has resigned his position as state highway engineer of North Carolina. He will continue in his position as business director of the American Road Builders' Association, director of the Highway Research Board of the National Research Council, and engineer-manager for Byrne Brothers Construction Co. in Mexico.

Obituary

S. D. COOPER, assistant manager of the timber treating plant of the Atchison, Topeka & Santa Fé Ry., died at Topeka, Kan., June 9. Mr. Cooper for many years had been active in the preservative treatment of timber for railway purposes. At the time of his death he was chairman of the Committee on Wood Preservation of the American Railway Engineering Association, and he was a past president of the American Wood Preservative Association.

EDWARD T. SCOVILL, Cleveland, Ohio, retired railroad builder who in the 1880's and 1890's built sections of the Northern Pacific, Southern Pacific and Canadian Pacific railroads, and also railroads in Peru, died in Paris, France, recently, aged 80 years.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Water Works Equipment and Materials at Convention

A.W.W.A. Examines Latest Products of Seventy-Nine Representative Manufacturers at Buffalo

(Engineering News-Record Staff Report)

THE results of the past year's progress in the manufacture of equipment and materials for every branch of the waterworks field were exhibited June 7-11 to 1,300 members and guests of the American Water Works Association in session at Buffalo, N. Y. Both the exhibit and the convention sessions were held in the Hotel Statler, so that the exhibit hall was continuously crowded with interested waterworks men. J. E. O'Leary, of the Pittsburgh-Des Moines Steel Co., was chairman of the Exhibit Committee of the Waterworks Manufacturers Association.

Especially noteworthy were the efforts the manufacturers made to explain interestingly and practically the different products. Moving picture reels were used extensively in this connection, while operating models of pumps, ditching machines, pipe manufacturing equipment, and the cut sections of meters, valves, etc., were other examples.

For purposes of classification, the seventy-nine exhibits may be divided into eight classes, consisting of four exhibits of chemicals and chlorinating equipment, three exhibits of filtration equipment, fifteen exhibits of meters and meter boxes, nineteen exhibits of pipe and pipe auxiliaries, seven exhibits of pumps and well apparatus, six exhibits of repair and construction equipment, twelve exhibits of valves, fittings, and hydrants, and a miscellaneous group of seven exhibits. The remaining number of the total exhibits was made up of technical publications.

Chemical and Chlorinating Equipment—More than the average developments were noted in this branch. Wallace & Tiernan had a large exhibit of chlorinating equipment, 80 per cent of which was new. A new automatic vacuum feed machine was featured, together with an improved one for automatic solution feed. New equipment known as a chloro-clock feeds a chlorine solution by displacement when a cylinder drops into the chlorine storage tank at a regulated rate. Still another new device was a dialed platform scale for charting directly the loss in weight as chlorine is used from the cylinder. Paradon Engineering Co. showed its standard equipment featuring the type of large machine it has installed in the new Buffalo filtration plant. For determination of hydrogen-ion concentration, the La Motte Chemical Products Co. showed a new piece of equipment carrying the test tubes of color standards and distilled water on a revolving drum. Much time and labor can be saved in testing by means of this roulette. The Electro Bleaching Gas Co. showed its standard equipment.

Filtration Equipment—Filter operating tables, dry chemical feed machines, orifice boxes, milk of lime feeders, rate controllers and Venturi tubes were exhibited. The manufacturers were, International Filter Co., F. B. Leopold Co., and Builders Iron Foundry.

Meters and Meter Boxes—The manufacturers of meters and meter boxes made especially practical exhibits by the use of sectional models showing the internal details of the equipment. Exhibits of meters were shown by Badger Meter Mfg. Co., Buffalo Meter Co., Federal Meter Corp., Gamon Meter Co., Hersey Mfg. Co., National Meter Co., Neptune Meter Co., Pittsburgh Meter Co., Union Water Meter Co., Van Gilder Water Meter Co., and Worthington Pump & Machinery Co.

Bingham & Taylor, H. W. Clark, and Ford Meter Box Co. displayed meter and valve boxes. Fred W. Hanks exhibited a flat type "no-warp" disk as a fabricating part for all makes of meters.

Pipe and Pipe Auxiliaries—Nineteen manufacturers of all kinds of pipes exhibited at the show. Attracting considerable attention was an operating model of the machines used by the American Cast Iron Pipe Co., for manufacturing its new product, Monocast centrifugal cast iron pipe. Samples of the pipe were also shown. B. Nicoll & Co. featured cast-iron pipe from the Pont-a-Mousson foundries in France, and showed some pipe dug from the fountain at Versailles and said to have been laid about 220 years ago. Riveted steel pipes, cast-iron pipes, cement lined and lead lined pipes, and concrete pipes were shown. Exhibitors were, in addition to the two mentioned, American Brass Co., Cement Lined Pipe Co., Central Foundry Co., East Jersey Pipe Co., Lead Lined Iron Pipe Co., Lock Joint Pipe Co., McWane Cast Iron Pipe Co., National Cast Iron Pipe Co., National Tube Co., U. S. Cast Iron Pipe & Foundry Co., and R. D. Wood & Co.

Types of auxiliaries shown included jointing materials and pipe coatings. Hydraulic Development Co., Leadite Co., and Victaulic Co. of America, showed jointing materials. The latter displayed a cast-iron rubber-gasketed joint extensively used in Europe for both low and high pressures; it is exceptionally flexible. The Talbot Non-Corrosive Linings Co. also introduced a European product to the American market. It is a centrifugally applied lining consisting of a bitumen mixed with a filler, generally of some hard siliceous material; a smooth mirrorlike surface results for the bore of the pipe. Wales-Dove-Hermiston, and Joseph Dixon Crucible Co. were the other exhibitors of pipe coatings.

Pumps and Well Apparatus—Operating models helped to make these exhibits especially useful. Sullivan Machinery Co. showed such a model of its "air-made" well for shallow sand and gravel formations. Layne & Bowler had two models of its vertical centrifugal pump for deep well operation. American Well Works operated a small model of its totally enclosed deep well pump. Edson Mfg. Co. exhibited diaphragm pumps, one of which was mounted on a rubber-tired trailer.

Sims Pump Valve Co. featured its inclined-port valve. Other exhibitors were: Edward E. Johnson, Inc., showing an automatic tank level control and deep well screens and the Birch Mfg. Co.

Repair and Construction Equipment—The two construction equipment exhibitors, Barber-Greene Co., and Giant Manufacturing Co., showed, respectively, models of a service trenching machine and a manual "pipe pusher" for installing small pipes without digging a ditch. Repair equipment was shown by National Water Main Cleaning Co., Joseph G. Pollard Co., A. P. Smith Mfg. Co., and Waterworks Equipment Co.

Valves, Fittings and Hydrants—Fire hydrants were shown by a majority of the valve manufacturers. Refinements in valves and special fittings are constantly being made, and space permits only saying that a great number of them were on display. The Mueller Co. had a large exhibit featuring a workbench where valve and fitting assemblies could be made. Exhibitors of valves fittings, and hydrants were Columbian Iron Works, Eddy Valve Co., Glauber Brass Mfg. Co., Hays Mfg. Co., Iowa Valve Co., Kennedy Valve Co., Ludlow Valve Mfg. Co., Michigan Valve & Foundry Co., Rensselaer Valve Co., Ross Valve Co., and Vogt Bros. Mfg. Co.

Miscellaneous—Companies exhibiting indicating devices were W. & L. E. Gurley showing flow meters and its line of surveying instruments, Republic Flow Meters Co., and the Simplex Valve & Hydrant Co., which had a large display of indicating and record-

Waterworks Manufacturers Elect

The Water Works Manufacturers Association held its annual meeting June 10 at the A.W.W.A. Convention in Buffalo. The members of the executive board that retired this year were re-elected. Following the meeting of the general association, the executive board met and elected the following officers for the ensuing year: John S. Warde, Rensselaer Valve Co., president; John E. O'Leary, Pittsburgh-Des Moines Steel Co., vice-president, and W. R. James, Mueller Co., treasurer. The convention committee elected was D. F. O'Brien, A. P. Smith Mfg. Co., James H. Caldwell, Ludlow Valve Mfg. Co., and Charles R. Wood, R. D. Wood & Co.

ing valves, plain and illuminated, for loss of head, rate of flow, pitot results, and wash water used, in addition to a display of manometers and rate-of-flow controllers. Steel tanks were featured by Chicago Bridge & Iron Works, and the Pittsburgh-Des Moines Steel Co. The Pitometer Co. showed the equipment used in its waste water surveys, while the Pittsburgh Testing Laboratory had literature describing its testing and inspection service.

Business Notes

ERNEST E. GAMON, formerly president of the Gamon Meter Co., has organized the Phoenix Meter Co., with headquarters at Princes Bay, N. Y., for the manufacture of disk type meters in ¾, ¾ and 1-in. sizes. Mr. Gamon is president of the newly organized company.

INTERFLASH SIGNAL CORP., New York, N. Y., manufacturers of marine, aviation and highway signals, announces that Edward W. Tree has been made advertising manager. For the past 10 years Mr. Tree has been identified with technical advertising and publishing and was recently editor and publisher of *Good Roads*.

YEOMANS BROTHERS CO., Chicago, manufacturers of sewage ejectors and pumping machinery, has recently appointed the General Equipment Co., Tampa, as its sales representative for central and southern Florida.

CHICAGO PNEUMATIC TOOL CO., New York City, announces its acquisition of the George Oldham & Sons Co., Baltimore. The manufacture of the Oldham pneumatic tools which are continued will be conducted at the Detroit plant. Sales will be combined and handled from the Chicago Pneumatic Tool Company's branches.

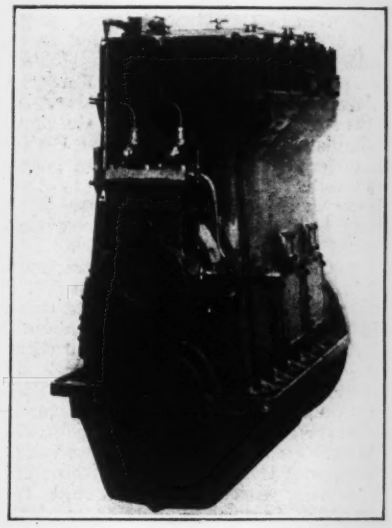
Equipment and Materials

High-Speed Diesel for Power Shovels

A light high-speed Diesel oil engine built especially for industrial machine use is now being manufactured by the Foos Gas Engine Co., Springfield, Ohio. The series of engine capsules range from 40 to 400 horsepower, having from one to eight cylinders. Speeds are set to meet the driven machine's requirements, usually ranging from 600 to 900 r.p.m.

In this new engine, one of the first American high-speed Diesels placed in commercial service, no spark plug, hot tube or other devise is used to ignite the fuel. The compression is carried to 450 lb., sufficient to provide auto ignition. Combustion proceeds at constant pressure, with the result that the cylinder pressure is but little higher than experienced in a gasoline engine. The weight ranges from 40 to 60 lb. per brake horsepower depending upon the number of cylinders.

No attempt has been made to reduce the weight by the last possible ounce for



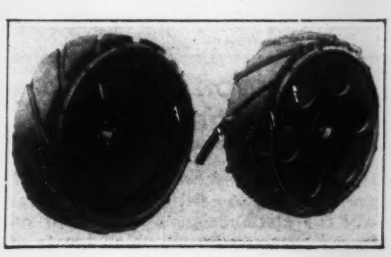
a fairly heavy weight is satisfactory for power shovel and excavator use, since it is customary to add dead weight to the platform when light-weight gasoline engines are used.

The fuel consumption is less than 0.45 lbs. per horsepower hour, using a fuel oil costing less than 5 cents per gallon. This figures out as approximately 17 horsepower hour per gal. or 3 mills per horsepower hour.

Fordson Wheels With Rubber Tires and Detachable Steel Lugs

The new cast wheel, manufactured by the Wehr Co., Milwaukee, Wis., has been designed to fill a need between rubber-tired equipment and a crawler unit. With the lugs removed, there is the equipment of a solid, non-skid tire for traveling paved streets, and while the use of the lugs does not entirely replace the crawler traction, it meets many needs where the investment for crawlers is too great for the use they would get.

Each wheel weighs 1,000 lb. and is cast hollow with openings to permit loading with a mixture of cement and steel punchings to bring the weight up an additional 400 to 700 lb. The lugs are of steel and held in place by the tapered grooves in the rim. One end of the lug has a hooked stop, while the other has a hole for a pin. This arrangement is claimed to be more permanent and durable than either riveted or bolted on lugs. Shipping weight per set of two wheels, including 24 lugs, is approximately 2,200 lb.



Tracing Paper Is White And Odorless

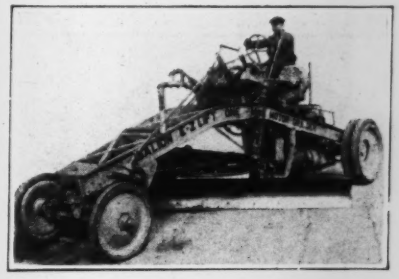
The tracing paper now being manufactured by the Special Paper Mfg. Co., 96 Reade St., New York City, is claimed to overcome two objectionable features characteristic of many vellums. The product is known as "Vellux" and is absolutely odorless and of a white texture. Claims made for the paper are that the odorless feature adds to the efficiency of the draftsman and that a white paper gives much better blueprints than does a yellow.

Roofs of Porcelain Enameled Sheet Steel

A roof material of interlocking units made of Armco ingot iron and enameled in a variety of colors is a product of the Vitrified Metallic Tile Roofing Co., Detroit, Mich. The tile is made of 22-gage metal, each unit weighing approximately 1 lb. so that it may be applied on any ordinary construction or even over old roofs. The enameled surface is non-corrosive, consisting of glass and flint fused into the iron at 1,400 to 1,600 deg.

New Fordson Powered Equipment for Road Work

Two road graders and a road roller all using a Fordson power plant are new products of the Galion Iron Works & Mfg. Co., Galion, Ohio. The graders are both one-man machines, the accompanying illustration showing the "EZ lift" motor grader. The other model, known as the "standard," is similar, except for certain refinements which are used on the "EZ lift." The first of these refinements is the lift mechanism consisting of an inclosed machine-cut steel worm gearing running in a bath of oil and aided by counter-balancing springs. The lift wheels are 40 in. in diameter with ball and socket joints on the lift. The side shift of the scraper is also accomplished by a worm gear. On both machines the operator is above the machine and in full view of the scraper blades. Also, both machines have a 16-ft. wheel base and an 8-in. channel frame. Three-point suspension is a feature of goth graders.



The 10-ton roller is also a new product being similar to the company's

smaller roller made in 3, 4, 5, 6 and 7-ton weights, but of considerably heavier construction.

New Bearing Has Oil Circulation and Filtration Features

A bearing, now being manufactured and distributed by the Willamette Iron & Steel Works, Portland, Ore., possesses the dual features of automatic circulation and filtration of the oil. Behind the bearing surface a reservoir is provided, from which the oil passes, through small feed passages, to the shaft. At each end of the bearing are provided oil return ducts, filled with wool waste, through which the oil is filtered. These ducts connect with the oil reservoir, and a definite circulation of lubricant is established and maintained. A feature of the bearing is provision so that the part subjected to the greatest pressure and the greatest friction gets the largest amount of oil. The results are said to be an unusual freedom from bearing trouble and a significant saving in the consumption of oil.

These bearings are being manufactured in flat bottom, internal collar, drop hanger, rigid post ball and socket, and various other types for special purposes to accommodate all shaft sizes.

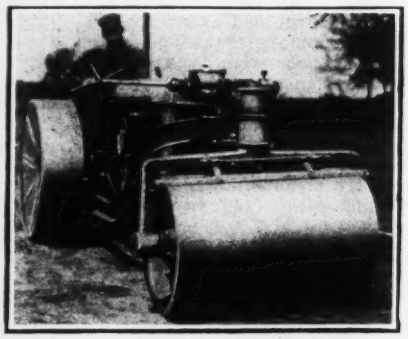
Equipment for the Road Builder

Recent additions to the line of equipment manufactured by the Hadfield-Penfield Steel Co., Bucyrus, Ohio, include a tandem road roller, a crawler tread for the Fordson tractor, and an automatic scraper.

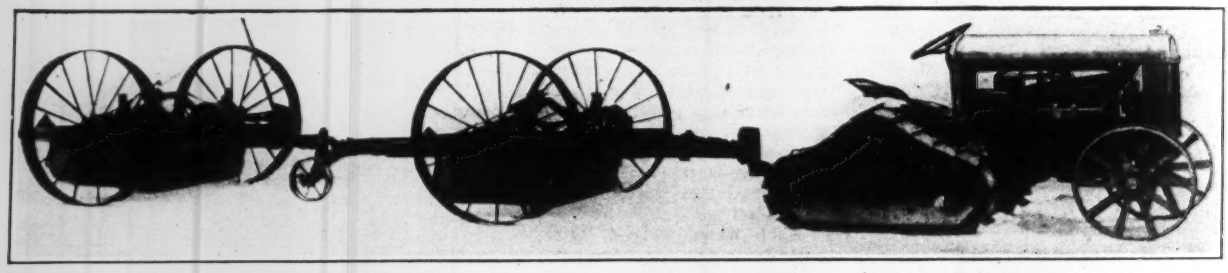
The Winchell tandem roller is made in 3, 4 and 5-ton sizes and used with Fordson power plants. These rollers are usually sold through Fordson dealers who supply the power plant. A feature of the machine is the steering mechanism which uses a regular Fordson differential worm and worm gear. The roller can be attached to the tractor in about an hour's time. The rolling width is 62 in. and the wheel base 96 in.

The Cahl Track Co., San Francisco, Calif., has been purchased and the Cahltrack will be added to the Hadfield-Penfield company's line of crawler mountings. The tracks can be furnished with any sort of equipment and are here illustrated with a Fordson tractor. The track on the ground is 42 x 12 in., and the bearing pressure per square inch is 3½ lb. Timken bearings are used and a feature of the track is the placing of the driving sprocket high enough to keep out of the dirt.

The third product is an automatic



scraper known as the "Du-Pat." The tractor operator has control of the depth of the cutting blade and when unloading he may spread the dirt at any desired depth. The scoop unloads by tipping forward. The scrapers, shown behind the tractor, are built in capacities of 1 and 2½ cu.yd.



Educational Film on Wrought-Iron Pipe Manufacture

The National Tube Co., Frick Building, Pittsburgh, Pa., has had prepared a second educational motion picture showing its methods of manufacturing wrought iron pipe. The new film, known as "The Arteries of Industry," gives an intelligent conception of the manufacture of wrought pipe by showing the series of operations in the mill and animated diagrams of some of the important processes. The first film, which has been out for some time, was of the same general nature and entitled "From Ore to National Pipe." These films are loaned without charge by the National Tube Co.

Publications from the Construction Industry

Wire Mesh Reinforcement—NATIONAL STEEL FABRIC CO., Pittsburgh, Pa., has ready for distribution a booklet on reinforced-concrete floors which treats of types of construction, floor surfaces, and design. Tables are given for designing reinforced-concrete slabs together with the style of National steel fabric reinforcement that is recommended with different thicknesses of slab. Tables are also given for computing the weight and area of the steel and the fabric.

Concrete Block—NATIONAL LIME ASSOCIATION, Washington, D. C., describes the use of lime in the manufacture of concrete blocks and other products in a recent bulletin No. 315. Much of the text is based upon the paper given at the American Concrete Institute meeting in February by P. C. Cutting, Director of Laboratories, Rock Island Arsenal, on the "Effect of Lime on Concrete Products."

Gasoline Engine Units—CLIMAX ENGINEERING CO., Clinton, Iowa, has issued new gasoline engine literature, consisting of three bulletins, describing the application of its engines. Bulletin E describes the portable and stationary types, designed for belt connection. Both outdoor and indoor service is provided for. Bulletin F describes the engine direct-connected to electric generators, both a.c. and d.c. from 20 to 75 kw. Bulletin G describes the unit direct-connected to a centrifugal pump.

Wire Rope In the Oil Fields—BRODERICK & BASCOM ROPE CO., St. Louis, Mo., present in a booklet entitled, "Driller," Know Your Ropes," the things it has learned from a study of the use of wire rope for the driller and oil producer. It states that "every attempt has been made to eliminate technicality," and that, "simple understandable language," is used to "explain what happens to a wire rope in drilling and how to get the most of the line." A number of illustrations are given explaining the different methods recommended.

Window Sash—DAVID LUPTON'S SONS CO., Philadelphia, has prepared a catalog on its projected sash, which opens beyond the window line and automatically stays open. The two types, architectural and industrial, are illustrated and a dozen pages of wall details for their installation are given.

Irrigation Pumping Plant—DE LAVAL STEAM TURBINE CO., Trenton, N. J., has published a new booklet on the use of its pumps in irrigation plants. The booklet illustrates and describes numerous farms and orchards irrigated by pumping in the fruit raising section of Oregon. Data are also given on the selection of pumps to suit the various requirements.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Where Extensive Paving Programs Are Most Needed

Requirements Gauged by Volume of Automobile and Motor Truck Registrations

THOSE states which require more active road building programs in order to accommodate the increasing volume of motor traffic, are indicated in the accompanying illustration.

The top-most of the three bars opposite the name of each state represents the money value of street and road contracts of $25,000 and over, awarded in that state during 1925, expressed as a percentage of the total street and road contract value for the entire United States in 1925.

The middle bar in each case represents the number of miles of public roads, paved or otherwise, existent in that state expressed as a percentage of the total road mileage of the entire United States.

The bottom bar for each state represents the number of automobile and motor truck registrations in that state for 1925, expressed as a percentage of the total registrations for the entire United States during the year.

Sixteen of the forty-eight states have a percentage figure for motor registrations in excess of that for road mileage, indicating the need, in some cases, for additional roads as well as hard surfacing of earth and gravel highways and more frequent repairs on those already paved.

The states in question are: Massachussetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Delaware, Florida, Indiana, Wisconsin, Michigan, Ohio, Illinois, Washington and California.

Of these sixteen, three states, namely, Delaware, Indiana and Wisconsin show a mileage figure smaller than that for registrations and one for contracts below that of mileage, indicating the future possibilities of road lettings in these specific localities. In the other thirteen, however, the volume of street and road contract letting is sufficiently great to make up for at least a part of the paving requirements.

In the remaining thirty-two states the road mileage comes nearer meeting requirements as indicated by motor registrations.

The figures for contracts awarded are taken from the Construction News section of *Engineering News-Record*. The mileage and registration figures are from the Bureau of Public Roads.

Heavy Brick Demand Continues —Yard Prices Easier

Considering the number of firms reporting and plants closed down, the demand for common brick is a very small fraction ahead of a year ago, as measured by unfilled orders booked by members of the Common Brick Manufacturers Association of America.

Increasingly heavy imports have not succeeded in preventing the usual scarcity occurring at this time of the year in the New York market. Prices everywhere are fairly steady. The average price at yard for the entire country was $13.313, May 1, 1926 as compared with $13.828 per M on the same date last year, a difference of 3.7 per cent.

The following tabulation shows the situation as reported by the C.B.M.A.:

	Burned Brick on Hand M	Shipped From Yards During Month M	Orders on Books M
May 1, 1926	265,093	146,431	277,412
Apr. 1, 1926	339,392	150,485	280,612
May 1, 1925	281,858	206,551	339,629

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Contracts Let at Minimum Mentioned for Entire U. S.

Week Ended	Public Work (*)	Private Projects (*)	Total Contracts (*)
June 17, 1926	$29,497	$27,896	$57,393
June 10, 1926	30,536	44,577	75,113
June 18, 1925	26,919	24,635	51,554
Heaviest Week:			
1926, Mar. 11	13,029	73,613	86,642
1925, Sept. 3	16,215	69,424	85,639
January 1 to date:			
1926	492,062	826,808	1,318,870
1925	473,371	609,386	1,082,757

(*) 000 omitted.

Lumber Reports Indicate Revival of Frame Building Demand

Exceptional activity is reported in lumber production, which has just passed its seasonal peak for the year, according to the National Lumber Manufacturers Association.

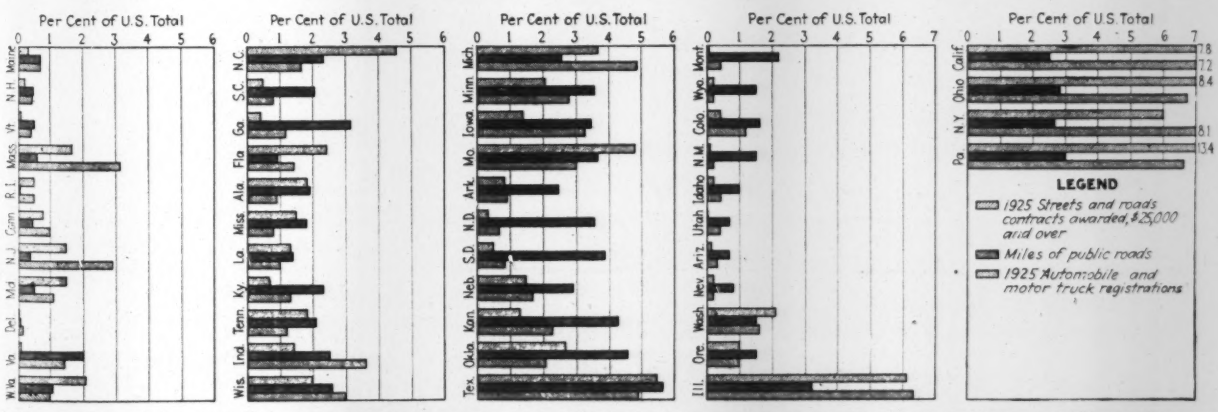
Comparison with 1925 shows a heavier output and a greater volume of shipments and new orders. Lumbermen are of the opinion that the extraordinary height of the seasonal peak is due to a revival of demand for frame construction in the smaller municipalities and also in the rural districts.

COMPARED WITH YEAR AGO

	Last Week In May Ft.	Corresponding Week in 1925 Ft.
Production	277,462,624	256,638,966
Shipments	268,852,027	262,488,808
Orders	266,879,695	249,154,190

FIRST TWENTY-ONE WEEKS

	Production Ft.	Shipments Ft.	Orders Ft.
1926	5,275,067,064	5,502,697,096	5,493,138,360
1925	5,209,157,766	5,290,095,784	5,158,640,633


Per Cent of U.S. Total
0 1 2 3 4 5 6
Wash. N.H. Vt. Mass. R.I. Conn. N.J. Md. Del. Va. W.Va.
N.C. S.C. Ga. Fla. Ala. Miss. La. Ky. Tenn. Ind. Wis.
Mich. Minn. Iowa Mo. Ark. N.D. S.D. Neb. Kan. Okla. Tex.
Mont. Wyo. Colo. N.M. Idaho Utah Ariz. Nev. Wash. Ore. Ill.
Calif. Ohio N.Y. Pa.
78 72 84 81 84
LEGEND
1925 Streets and roads contracts awarded, $25,000 and over
Miles of public roads
1925 Automobile and motor truck registrations

MOTOR REGISTRATIONS INDICATE NECESSITY FOR MORE ACTIVE PAVING PROGRAMS IN AT LEAST ONE-THIRD OF THESE STATES

Weekly Construction Market

CONSISTENT with the generally firmer tone in wholesale prices, construction materials show little tendency to fluctuate. Lumber remains unchanged in over half the number of cities reporting this week; slight easing, however, is developing at some of the Southern mill points. Linseed oil has risen 5½c. in New York and 4½c. per 7½ lb.-gal. at Minneapolis, since June 8. At Birmingham, No. 2 foundry pig iron is down $1 per ton to $21, as against $22 one month ago and $20@$21 at this time last year; inquiries are more active in New York. Steel reinforcing bars and structural shapes are quoted at $2 per 100 lb., Pittsburgh, for large tonnages; $2.10 applying on quantities under 100 tons. Building trades wage disputes and other labor troubles are in force in eighteen localities throughout the country. With the exception of the masons' and bricklayers' strike at Troy, N. Y., the other seventeen controversies were mentioned in *E. N.-R.*, issue of June 3. Settlements effected during the past two weeks were as follows: Hartford, Conn., hod carriers and building laborers returned at the old wage of 90c. per hr.; Aberdeen, Wash., carpenters terminated three-weeks' strike by accepting $1.06¼ per hr., an advance from the old rate of $1, after having demanded $1.12½; Denver, Colo., carpenters agreed to a rate of $10 per day on jobs awarded since Jan. 23, the old wage of $9 applying on all previous contracts; Washington, D. C., carpenters accepted an advance of 50c. per day instead of $1 originally demanded, agreement to hold until 1928; Chicago, Ill., iron workers returned to work pending a grant of $1.50 per hr., effective Oct. 1, present rate of $1.37½ to remain in force until then.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.40	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$4.00
Structural rivets, 100 lb.	4.50	3.50	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.77½	3.10	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	55%	54.25%	36%	35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@53.60	45.30	54.00	49.20@50.20	53.00	64.00	52.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾-in., cu.yd.	1.85	2.50	2.83	1.87½	1.75	2.50	1.80	3.00	1.70
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	41.00	39.00@39.75	34.75	27.00	25.00	55.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.25@2.75	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.10	10.50	14.10	12.00	14.25	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.075	.076	.075	.....	.09	.12
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.075	.076	.075	.108	.09	.10
Linseed oil, raw, 5 bbl. lots, gal.	+.89¼	.90¾	1.13	+.92	+.98¼	+1.11	.97	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	82½	.45@.60	40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93⅝c.; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 3 the next on July 1.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.109). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83.

Business Briefs

Call money quoted at 4 per cent, June 14; year ago 3½ per cent.

Time loans: sixty-ninety days, 4@4⅛; four-six months, 4⅛@4¼ per cent.

Commercial paper: best names 4 per cent; other names, 4¼ per cent.

On June 1, 1926

E. N.-R. Construction Cost Index Number 204.80

E. N.-R. Construction Volume Index Number 254

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month